

Trouble-shooting instructions : OPE-5019
BOSCH system : ABS
Make of vehicle : OPEL
Basic microcard : KFZ-00..

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SPECIAL FEATURES

This microcard, valid at the time of publication, contains trouble-shooting instructions for the following models:

- * OPEL Vectra 2,0l 10.1988->
- * OPEL Vectra 4x4 01.1989->
- * ABS with 4 wheel-speed sensors and 4 hydraulic channels.
- * Sensor ring gear with 43 teeth.
- * The fuse (F19) must be removed when testing brakes and performance of Vectra 4x4 on test bench. The rear axle is then disconnected from the drive train.

STRUCTURE, USAGE

These brief instructions encompass essentially vehicle-specific special features and test specifications (set values).

For a detailed description of trouble-shooting, see the basic instructions.

ATTENTION :
The set values, terminal assignments and special features of these vehicle-specific brief instructions are always binding.

SAFETY AND PRECAUTIONARY MEASURES

- *For reasons of safety, the hydraulic modulator must not be repaired, but may be exchanged only as a complete unit. Exception: relays
- *Do not loosen any screws on the hydraulic modulator! Danger of fatal accident owing to failure of the brakes.
- *Take great care when handling brake fluid. Poison!

For further information, see brief instructions.

PREREQUISITES FOR TESTING WITH ABS 2-LED TESTER

- * Regulation tire size fitted ?
- * Check tightness of ground connection of return pump.
- * Check ground connection of over-voltage protection relay term. 31 for tightness and corrosion.
- * Check tightness of ground strap between engine block and vehicle frame.
- * Check hydraulic connections at hydraulic modulator and sealing points for leaks (visual inspection).
- * If the ABS warning lamp lights up from time to time when driving (e.g. after switching on loads) and goes out again automatically, check battery and voltage supply (alternator, regulator and voltage dips).
- * Check following items if ABS warning lamp lights up all the time and does not go out:
 - Is controller plug properly connected to controller and engaged ?
 - All plug contacts O.K. ?
 - Spring contacts engaged ?
 - Check correctness of installation position of sealing ring in controller plug: curvature downwards.
 - Check proper assignment of wheel-speed-sensor leads at controller plug:

Wheel-speed sensor:

Front left to term. 5 and term. 4.
Front right to term. 11 and term. 21.
Rear left to term. 7 and term. 9.
Rear right to term. 24 and term. 26.
Rear axle to term. - and term. -.

Wheel-speed sensor:

on Vectra 4x4
front left to term. 22 and term. 4.

- V-belt snapped?
(No voltage supply from alternator, charge indicator lamp and ABS warning lamp light up).
- * Connect ABS 2-LED tester to ABS wiring harness.
- Only detach and connect controller with ignition switched off.
- For test purposes, switch on ignition in all program-selector-switch positions (tester uses power supply from vehicle battery).
- Observe LED (green) for power supply in all program-selector-switch positions.

I M P O R T A N T !

Never drive with tester connected !
Brake system must be bled before carrying out ABS test.
Do not actuate ABS tester during bleeding process.
The entire test program is to be repeated whenever repairs have been performed.
The anti-lock braking system is a vehicle safety system.
Work on this system requires detailed system knowledge.
The conventional brake system must be in proper working order.

General notes on trouble-shooting:

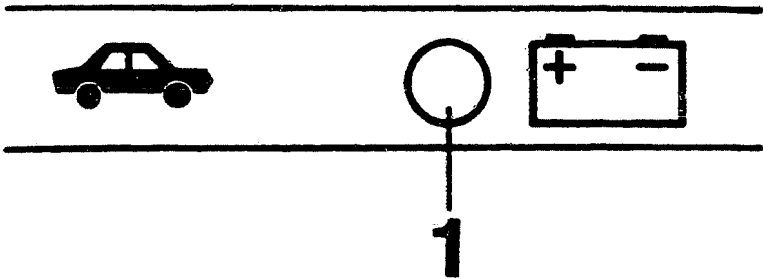
Check all leads for short-circuit to ground and contact with positive leads as well as for wear and pinching.

RAPID DIAGNOSIS CHART

Do not drive with tester connected. Are all test conditions met?

Program-switch positions 1 to 6

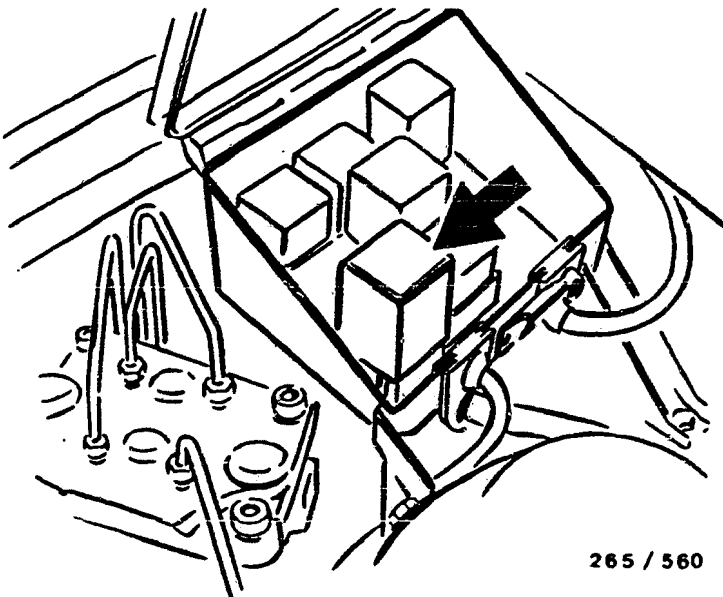
Testing of (measurement at terminals)	Additional operation	Test specifi- cation (reading)	Possible causes of faults
Power supply (term.1 und term.20)	Ignition on	LED 1 (top picture) continuously lit	<div>*Battery insufficiently charged</div> <div>*High voltage drops</div> <div> *Overvoltage-protection relay defective</div> <div> *Check lead to ignition and starting switch, term. 15</div>



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1 = LED for supply voltage

Arrow = Overvoltage-protection relay

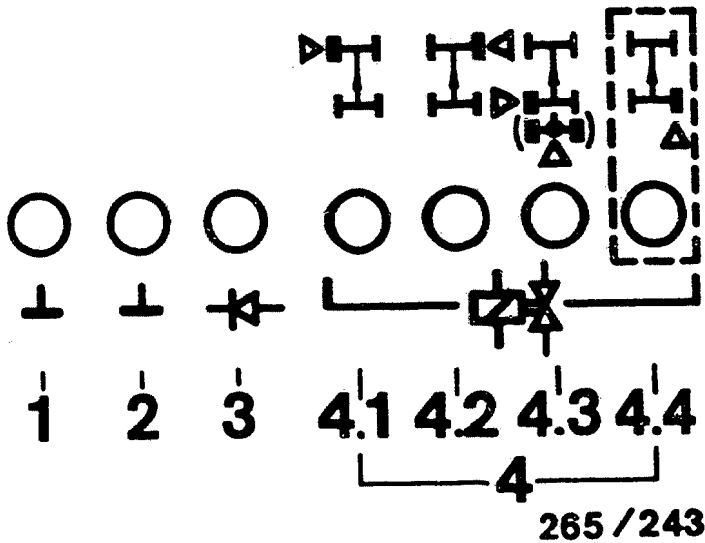


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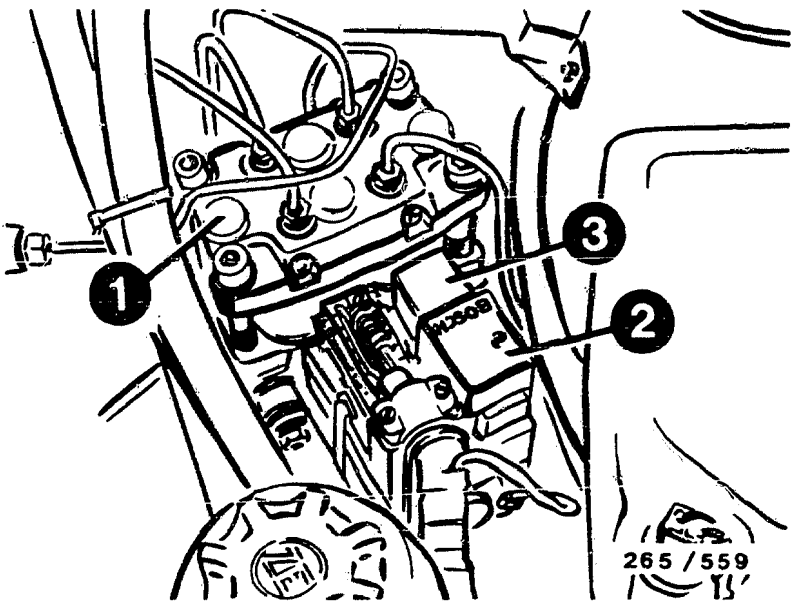
RAPID DIAGNOSIS CHART (CONTINUED)

Program-switch position 1 (4-channel hydraulic modulator)

Testing of (measurement at terminals)	Addition- al operation	Test specifi- cation (reading)	Possible causes of faults
Ground connection (term.10, term.34) Diode for warning lamp (term.29, term.32) Solenoid-operated valve internal res. (term.2, term.18, term.19, term.35) Off-position and ground connection of relay ABS warning lamp	Ignition on	7 LED (1 to 4.4) simultaneously brightly lit (top picture) ABS warning lamp in vehicle must light up	<ul style="list-style-type: none">* LED 1 and/or 2 (top picture) not lit: Check ground terminals for open circuit.* LED 3 (top picture) not lit: Diode defective, check ground connection of valve relay.* One or more LEDs 4 not lit: Check corresponding plug-in connection for solenoid-operated valve and leads.Solenoid-operated valve internal resistance 0,7...1,7 Ω* All LEDs 4 and LEDs 3 not lit: Check ground connection of valve relay, valve relay defective.* Dimmer lighting-up of an LED means contact resistance in the corresponding circuit.* ABS warning lamp not lit: Warning lamp defective. Note: all other 6 LEDs lit.



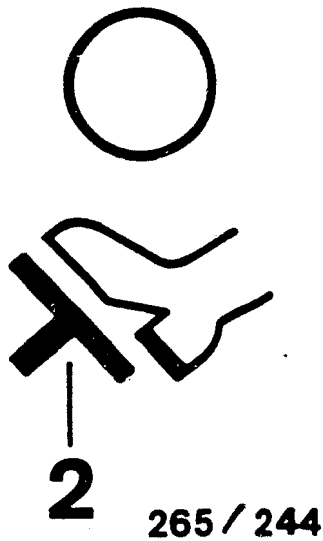
- 1 = Hydraulic modulator
- 2 = Motor relay
- 3 = Valve relay



RAPID DIAGNOSIS CHART (CONTINUED)

Program-selector-switch position 2

Under test (Measurement at the terminals)	Addition- al operation	Test specifi- cation (reading)	Possible causes of trouble
Alternator voltage from term. 61/D+ (term. 15)	Ignition on	LED 1 (top picture) lit.	* In some cases, LED does not go out until after burst of throttle (test is O.K. in this case).
	Start engine	LED 1 (top picture) goes out when engine running	* Test lead and signal from alternator term. 61/D+ * Alternator defective.
Stop-lamp switch (term.25)	Ignition on	LED 2 (top picture) lit	* Stop-lamp switch defective. * Check lead to stop-lamp switch.
	Press brake pedal	LED 2 (top picture) goes out	* Lead incorrectly connected to to stop-lamp switch.

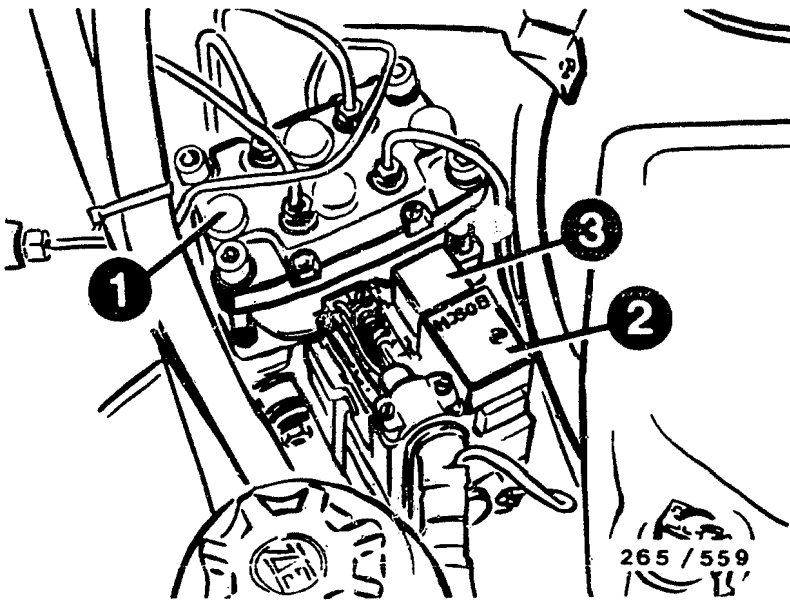
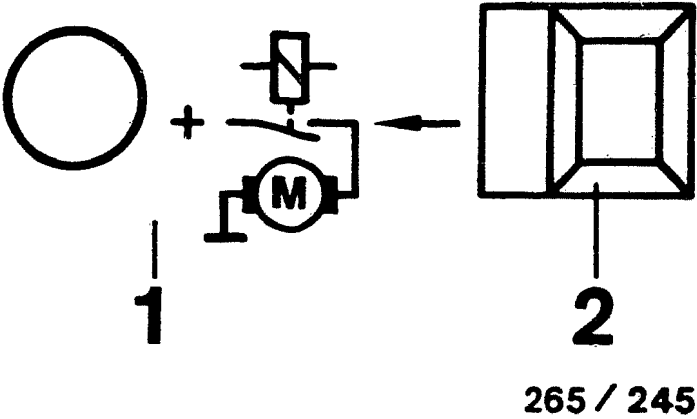


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RAPID DIAGNOSIS CHART (CONTINUED)

Program-selector-switch position 3

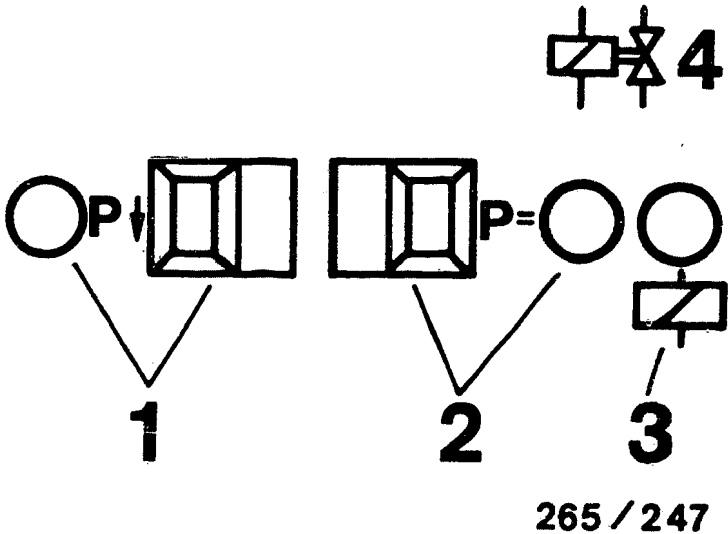
Under test (Measurement at the terminals)	Additional operation	Test specification (reading)	Possible causes of trouble
Motor relay (2), pump motor in hydraulic modulator (1) (t.28 and t.14) (center picture)	Ignition on, press button 2 constantly (top picture)	LED 1 lights up, pump motor runs. After releasing button, LED continues to light up due to run-on of motor (top picture).	<ul style="list-style-type: none">* Motor relay defective* Check ground connection and positive terminal of pump motor* Check following leads: From controller t.14 and t.28 to hydraulic modulator t.9 and t.11 . Positive leads to hydraulic modulator t.2 and t.13.* Pump motor or hydraulic modulator defective.



Program-selector-switch position 4 not applicable.

Program-selector-switch position 5 (4-channel hydraulic modulator)

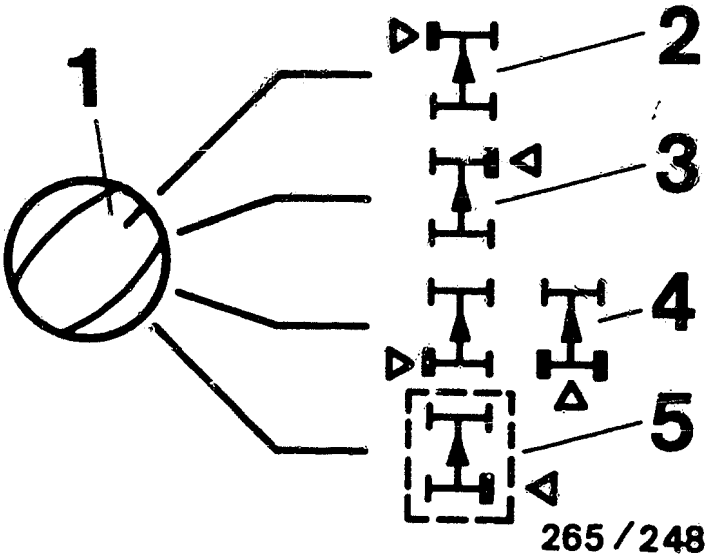
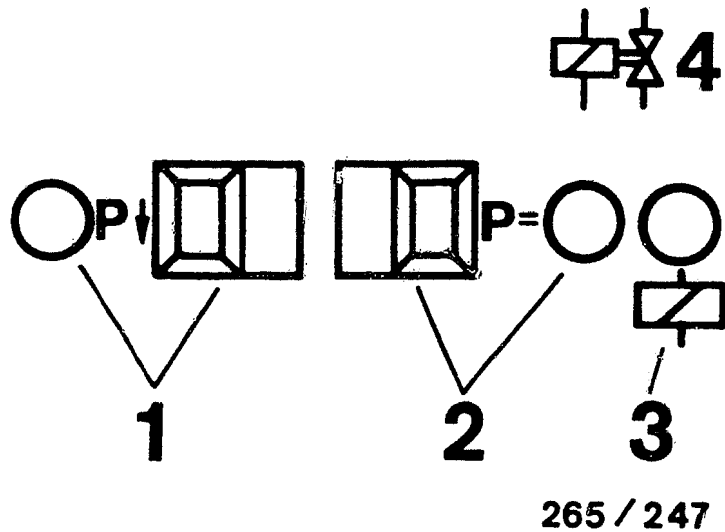
Under test (Measurement at the term.)	Additional operation	Test specifi- cation (reading)	Possible causes of trouble
Valve-relay function (t.27)	Ignition on	LED 3 (bottom picture) lights up	<ul style="list-style-type: none">* Valve relay (winding) or leads defective



Program-selector-switch position 5 (continued) see next Coordinate!

RAPID DIAGNOSIS CHART (CONTINUED)
 Program-selector-switch position 5 (4-channel hydraulic modulator)

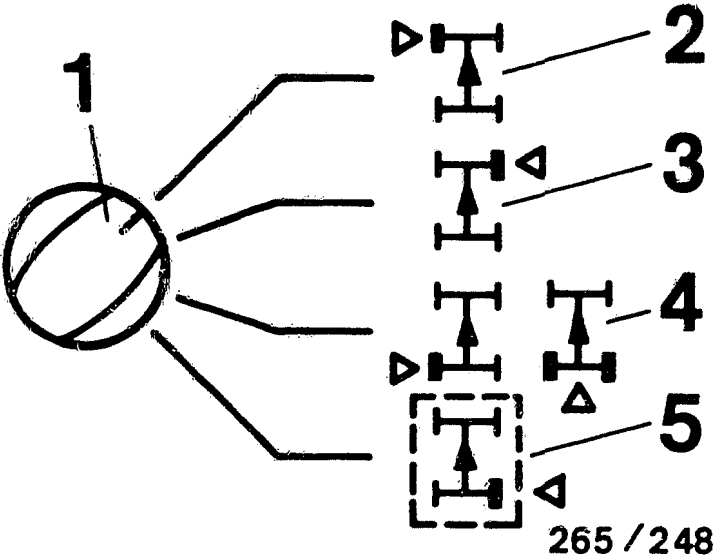
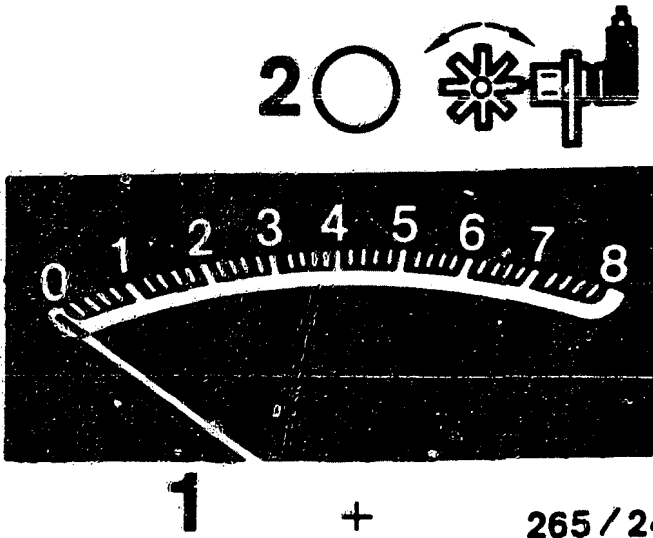
Under test (measurement at the terminals)	Additional operation	Test specification (reading)	Possible causes of trouble
Check solenoid valves in hydraulic modulator for proper function and mix-ups. NOTE: Perform test consecutively for each individual wheel. Stick to sequence of operations!	Jack up vehicle. Ignition on. It must be possible to turn the wheel to be tested freely by hand. Set switch 1 for wheel selection to the wheel to be tested. (Bottom picture) Selector lever on "N" with automatic transmission; on idle with manual transmission.		<ul style="list-style-type: none"> * Repeat test with engine running * Valve relay (make contact) defective * Open-circuit in lead from valve relay term. 87 to B+ * Brake lines at hydraulic modulator mixed up
Constant pressure function	1. Press button P= (top picture) constantly	LED P= (top picture) lights up	<ul style="list-style-type: none"> * Current value is not reached (LED P arrow or P= go out; top picture); battery not sufficiently charged. Repeat test with engine running.
	2. Press brake pedal constantly	Wheel can be turned by hand	
	3. Release button P= (top picture)	LED P= goes out (top picture) Wheel locks	
Pressure reduction function	4. Press button P arrow (top picture)	LED P arrow (top picture) lights up, wheel can be turned by hand	<ul style="list-style-type: none"> * Proper electrical connections for solenoid valves? Wheel, front left: t. 2 Wheel, fr. right: t.35 Wheel, rear left: t.18 Wheel, rear right: t.19 Rear axle: t.- * Hydraulic modulator defective
	5. Release button P arrow (top picture)	LED P arrow (top picture) goes out, wheel locks	
	6. Release brake pedal		



RAPID DIAGNOSIS CHART (CONTINUED)

Program-selector-switch position 6 (4 wheel-speed sensors)

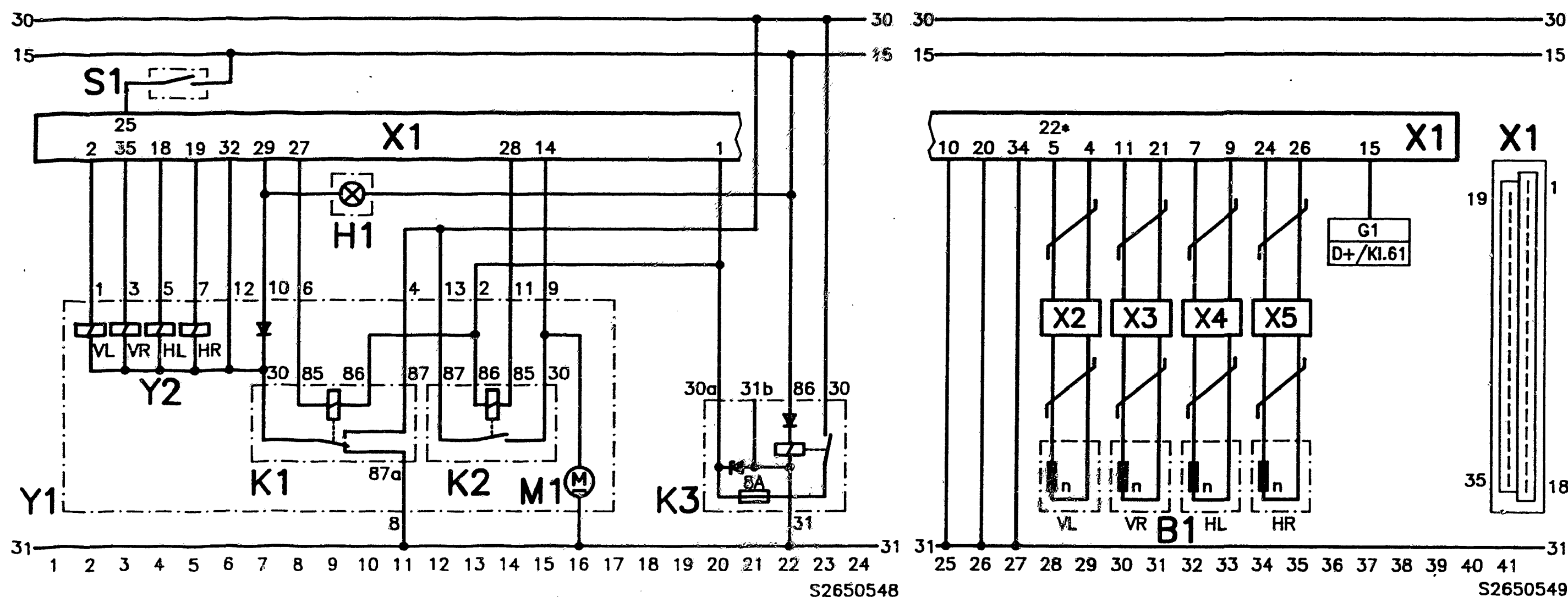
Under test (measurement at the terminals)	Additional operation	Test specification (reading)	Possible causes of trouble
<p>Check wheel-speed sensors for proper functioning and mix-ups</p> <p>NOTE: Perform test consecutively for each individual wheel.</p> <p>Wheel, front left: t.5 and t.4</p> <p>for Vectra 4x4 t.22 and t.4</p> <p>Wheel, front right: t.11 and t.21</p> <p>Wheel, rear left: t.7 and t.9</p> <p>Wheel, rear left: t.24 and t.26</p>	<p>Jack up vehicle. Ignition on.</p> <p>It must be possible to turn the wheel to be tested freely by hand.</p> <p>The wheel not being tested must be held when testing the driven axle.</p> <p>Set switch for wheel selection to wheel to be tested (bottom picture)</p> <p>Turn wheel by hand until LED 2 above instrument lights up without flickering. (Speed approx. 1 revolution per second). Then read off display on instrument: (top picture)</p>	<p>1.Smallest display greater than 1,6 scale divisions</p> <p>2.Permissible fluctuation band max. 25 % from highest reading.</p>	<p>*Wheel-speed-sensor lead mixed up</p> <p>*Open-circuit in wheel-speed-sensor lead</p> <p>*Wheel-speed sensor defective</p> <p>Winding resistance Front axle: 600...1600 Ω Rear axle: 600...1600 Ω</p> <p>*Air gap between wheel-speed sensor and ring gear too large</p> <p>*Ring gear defective (e.g. corroded, dirty) or loose</p> <p>*Ring gear with incorrect no. of teeth installed Front axle: 43 teeth Rear axle: 43 teeth</p> <p>*Too much wheel-bearing play</p> <p>*Reading given, LED2 does not light up: loose contact in wheel-speed-sensor lead.</p>



TEST SPECIFICATIONS

Wheel-speed sensor		
* Winding resistance at ambient temperature (-10°C...+120°C) for front axle:	600...1600	Ω
rear axle:	600...1600	Ω
Hydraulic-modulator solenoid valves		
* Winding resistance at ambient temperature (-10°C...+120°C):	0,7...1,7	Ω
Tightening torque for		
* Fastening screws of wheel-speed sensors:	> 8	Nm
* Brake-line connections at hydraulic modulator:	12...16	Nm
Number of teeth		
* front axle:	43	teeth
* rear axle:	43	teeth

For production reasons:
continued on the following
coordinate.



ELECTRICAL TERMINAL DIAGRAM

B1 = Wheel-speed sensor

G1 = to alternator

H1 = ABS warning lamp

K1 = Valve relay

K2 = Motor relay

K3 = Over-voltage protection relay

* = With Vectra 4x4 the terminal at the wheel-speed sensor VL changes from term.5 to term.22

M1 = Return pump motor

S1 = Stop-lamp switch

X1 = Controller plug (35-pole)

X2...X5 = Multiple butt connectors

Y1 = Hydraulic modulator

Y2 = Solenoid valves

VL = front left

VR = front right

H = rear axle

HL = rear left

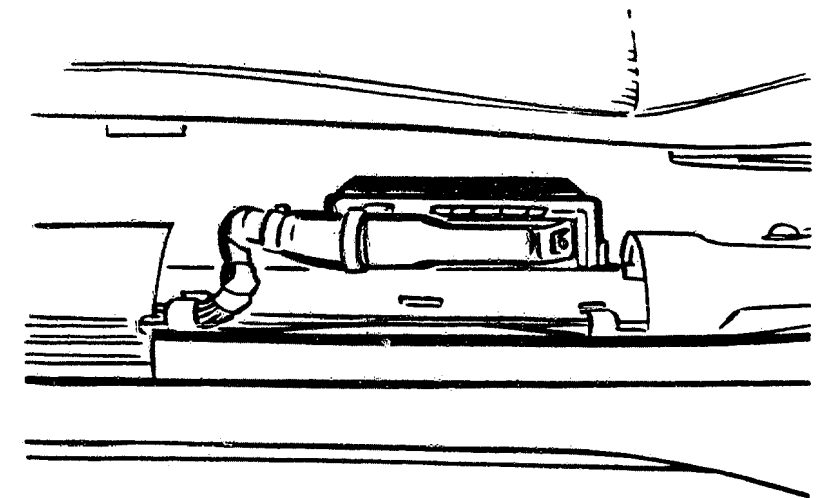
HR = rear right

INSTALLATION POSITION OF COMPONENTS

The installation positions always refer to the direction of travel.

* Controller:

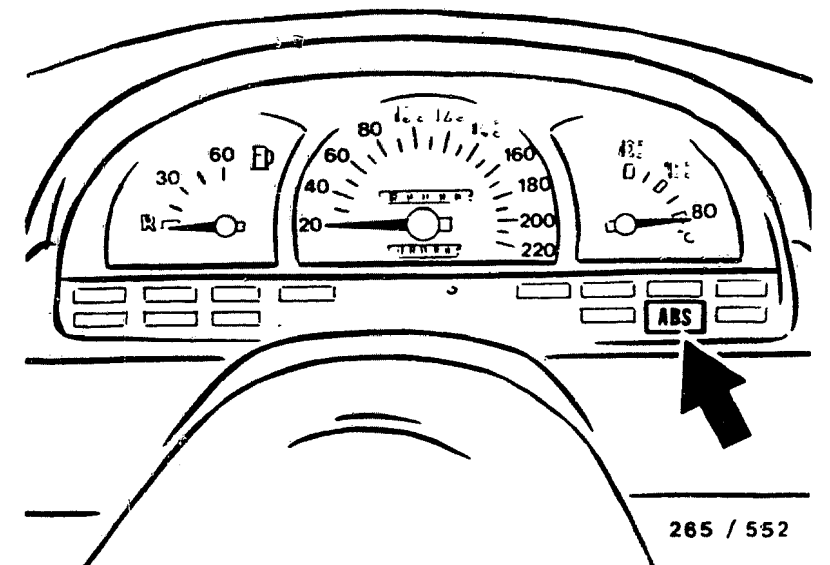
Fitted on left-hand side at sill (top picture).



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* ABS warning lamp:

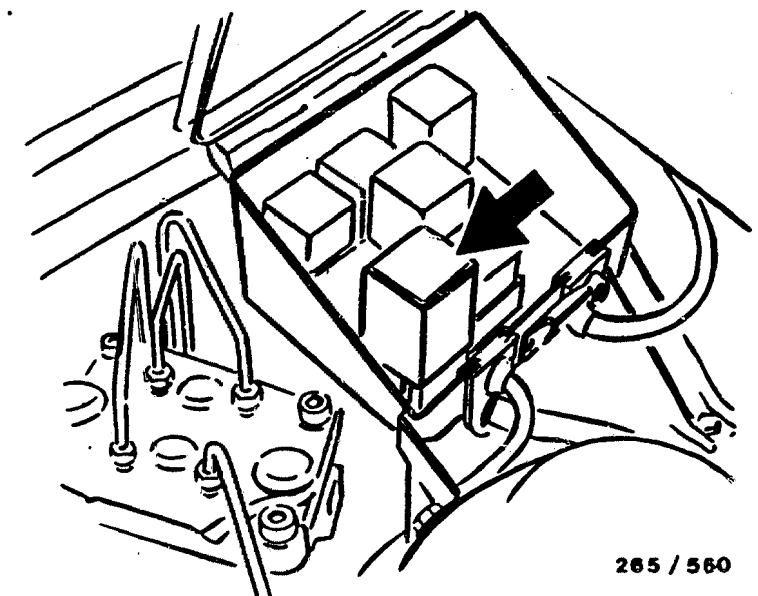
2nd indicator lamp (center picture) from right in instrument panel in indicator-lamp strip.



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* Over-voltage protection relay:

On left in engine compartment in vicinity of bulkhead in relay box (arrow), (bottom picture).

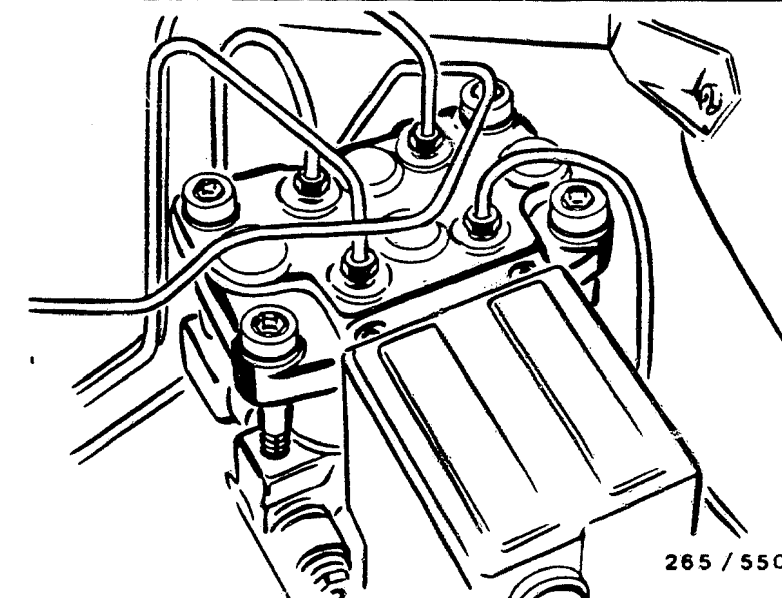


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INSTALLATION POSITION OF COMPONENTS (CONTINUED)

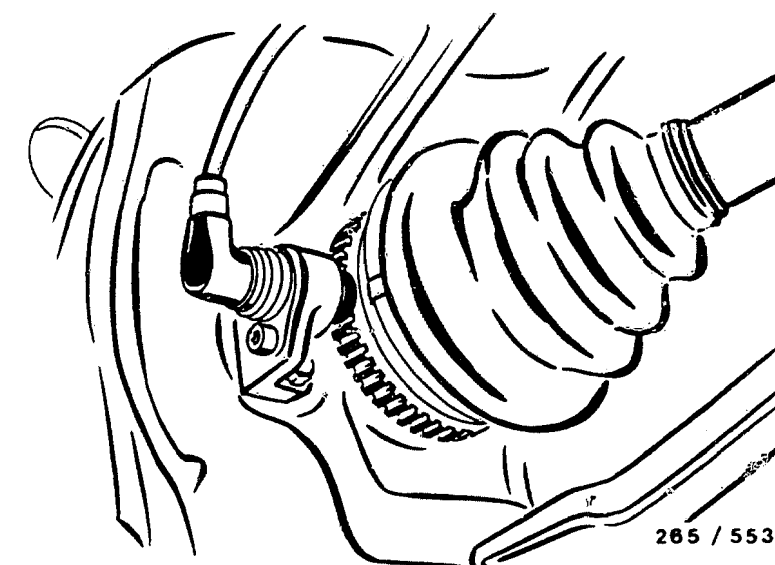
* Hydraulic modulator:

In front left of engine compartment (top picture).



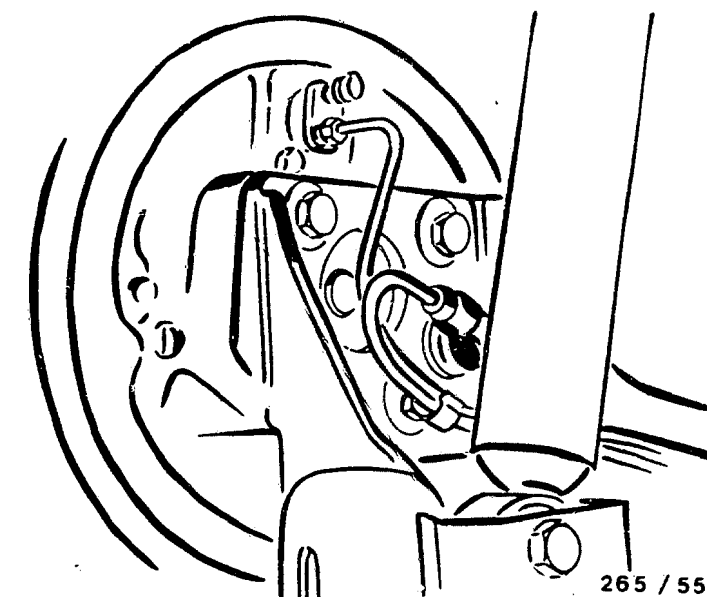
* Wheel-speed sensor, front axle:

One wheel-speed sensor each on left and right at steering knuckle (center picture). Wheel-speed sensors cannot be adjusted.



* Wheel-speed sensor, rear axle:

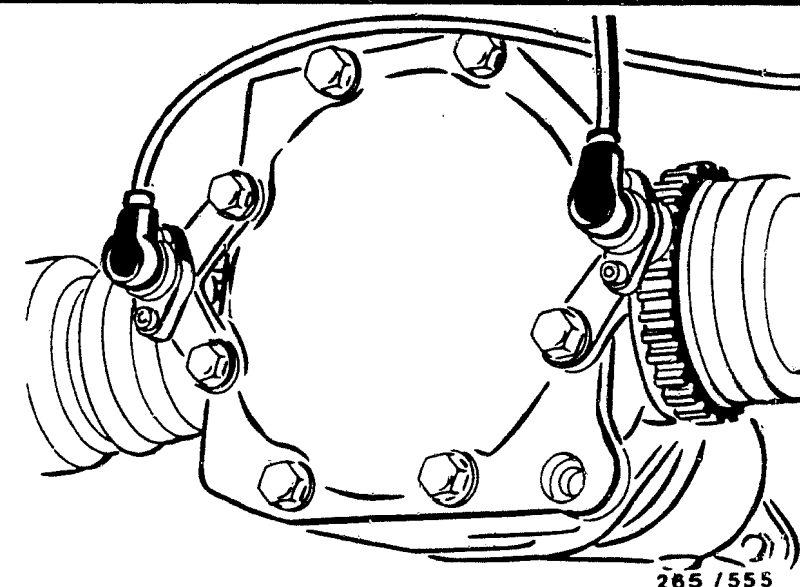
One wheel-speed sensor each on left and right at rear axle (bottom picture). Wheel-speed sensors cannot be adjusted.



INSTALLATION POSITION OF COMPONENTS (CONTINUED)

* Wheel-speed sensor, rear axle (Vectra 4x4 only):

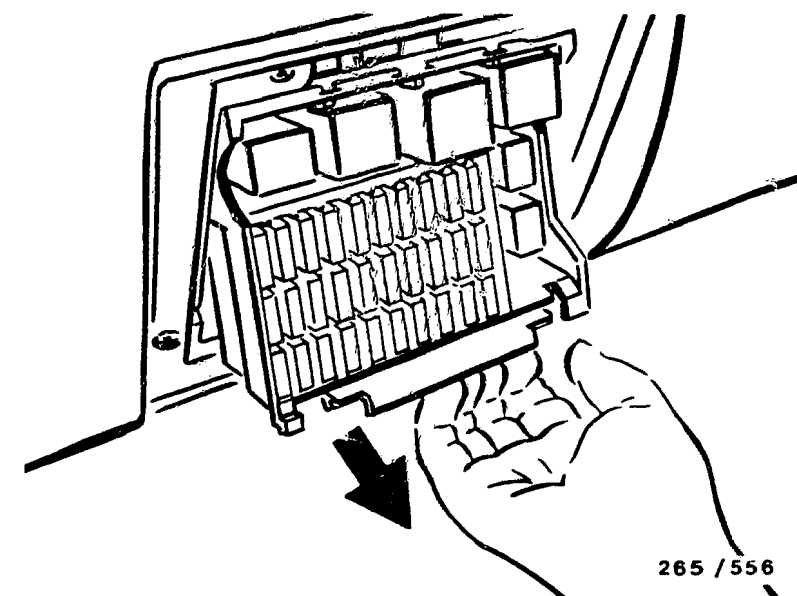
One each on left and right at differential, (top picture)



* Fuse box:

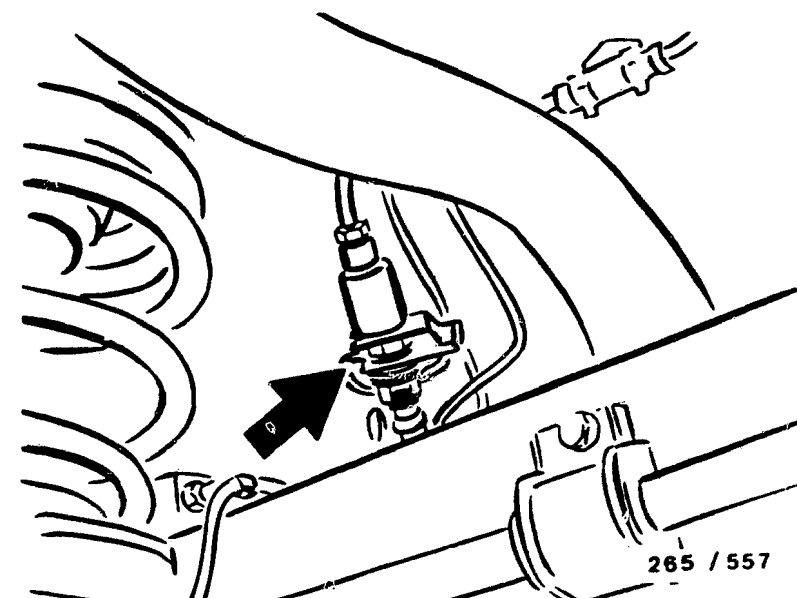
On left beneath instrument panel

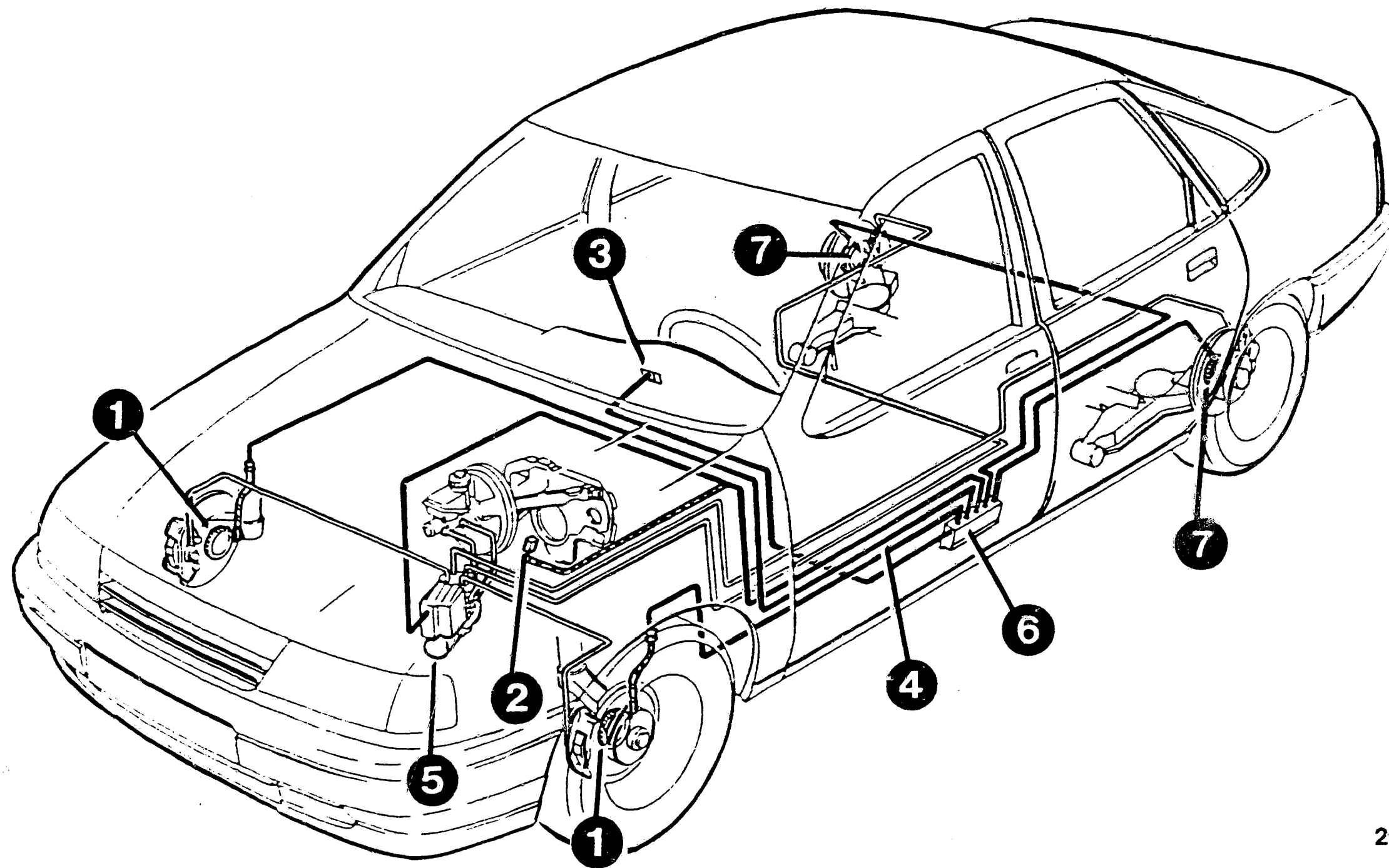
Fuse F19 for disconnecting the 4-wheel drive is located in the center row of fuses (second from right), (center picture).



* Brake pressure regulator:

One each on left and right above rear axle at vehicle underbody (bottom picture).





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INSTALLATION POSITION OF COMPONENTS (CONTINUED) Vectra 2.0 i

- 1 = Wheel-speed sensor, front axle
- 2 = Over-voltage protection relay
- 3 = ABS warning lamp
- 4 = ABS wiring harness

- 5 = Hydraulic modulator
- 6 = ABS controller
- 7 = Wheel-speed sensor, rear axle

Trouble-shooting instructions : POR-5005
BOSCH system : ABS
Make of vehicle : PORSCHE
Basic microcard : KFZ-00..

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SPECIAL FEATURES

This microcard contains the trouble-shooting instructions, valid at the time of publication, for the following model:

Porsche 944 08.1986 ->

- * ABS with 4 wheel-speed sensors and 3 hydraulic channels.
- * Sensor ring gear with 45 teeth.
- * 944 S and 944 Turbo only:
braking-force regulator for rear axle screwed on to hydraulic modulator (connection h).

STRUCTURE, USAGE

These brief instructions encompass essentially vehicle-specific special features and test specifications (set values).

For a detailed description of trouble-shooting, see the basic instructions.

ATTENTION :
The set values, terminal assignments and special features of these vehicle-specific brief instructions are always binding.

SAFETY AND PRECAUTIONARY MEASURES

- * For safety reasons, the hydraulic modulator must not be repaired, but be exchanged as a complete unit.
Exception: relays.
- * Do not loosen any screws on the hydraulic modulator!
Danger of fatal accident due to brake failure.
- * Caution when handling brake fluid.
Poisonous!

For further information, see basic instructions.

TEST REQUIREMENTS FOR TESTING WITH ABS2 LED TESTER

- * Regulatory tire size fitted?
- * Check for firm seating of ground of return-supply pump.
- * Check for firm seating and corrosion of ground of overvoltage-protection relay term. 31.
- * Check for firm seating of ground strap between engine block and vehicle frame.
- * Check for leaks in hydraulic connections at hydraulic modulator and sealing points (visual examination).
- * If the ABS warning lamp lights up intermittently when driving (e.g. after switching on loads) and goes out again by itself, check the battery and power supply (alternator, regulator and voltage drops).
- * If the ABS warning lamp lights up constantly and does not go out, check the following points:
 - Controller plug sitting correctly on controller and latched?
 - All plug contacts O.K.?
 - Spring contacts latched?
 - Check installation position for correct seating of seal ring in controller plug. rounded side downward.

- Check wheel-speed-sensor leads for correct assignment at controller plug:

Wheel-speed sensors:

front left to term. 6 and term. 4.
front right to term. 11 and term. 21.
rear left to term. 8 and term. 9.
rear right to term. 24 and term. 26.
rear axle to term. - and term. -.

- V-belt snapped?
(Alternator provides no voltage, charge-indicator lamp and ABS warning lamp light up).
- * Connect ABS 2 LED tester to ABS wiring harness.
- Disconnect and connect controller only with ignition switched off.
- For testing, switch on ignition in all program-selector-switch positions (tester operates with current supply from vehicle battery).
- Observe LED (green) for current supply in all program-selector-switch positions.

C A U T I O N !

Do not drive with tester connected!

The brake system must be bled of air before the ABS test. Do not activate the ABS tester while the system is being bled.

Repeat the complete test program after any repairs are carried out.

The Antiskid System is a vehicle safety system.

Work on the system demands detailed knowledge of the system.

The conventional brake system must be O.K.

General information for trouble-shooting:

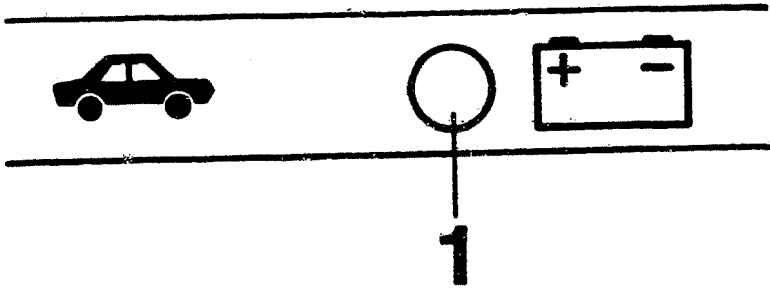
Check all leads for short circuit to ground and contact with positive leads and watch out for worn cable insulation and pinched leads.

RAPID DIAGNOSIS CHART

Do not drive with tester connected. Are all test conditions met?

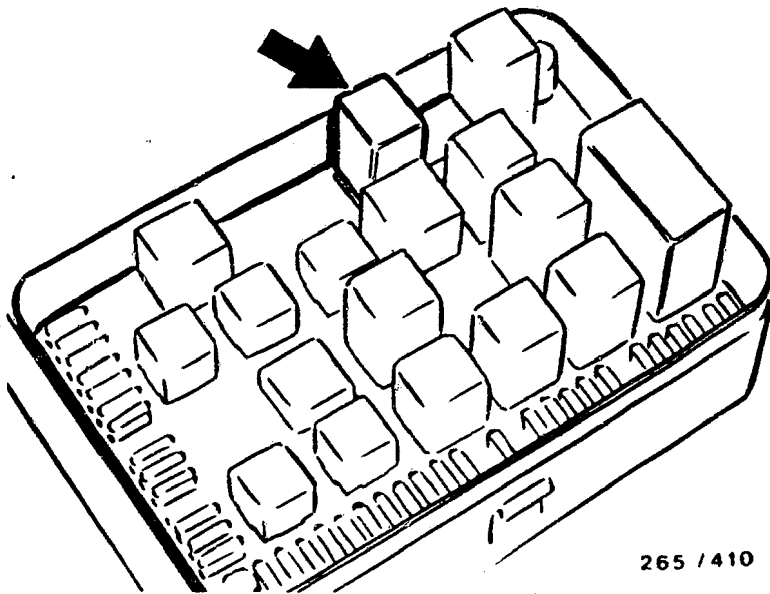
Program-switch positions 1 to 6

Testing of (measurement at terminals)	Additional operation	Test specifi- cation (reading)	Possible causes of faults
Power supply (term.1 und term.20)	Ignition on	LED 1 (top picture) continuously lit	<ul style="list-style-type: none">*Battery insufficiently charged*High voltage drops*Overvoltage-protection relay defective*Check lead to ignition and starting switch, term. 15



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Arrow = Overvoltage-
protection relay

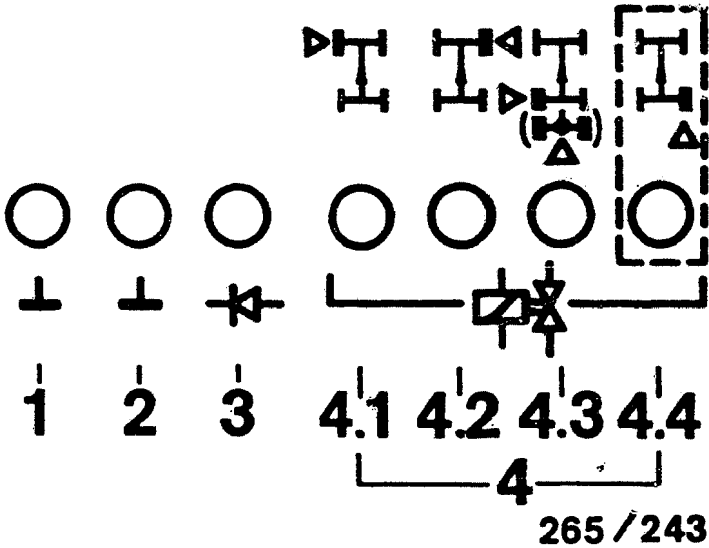


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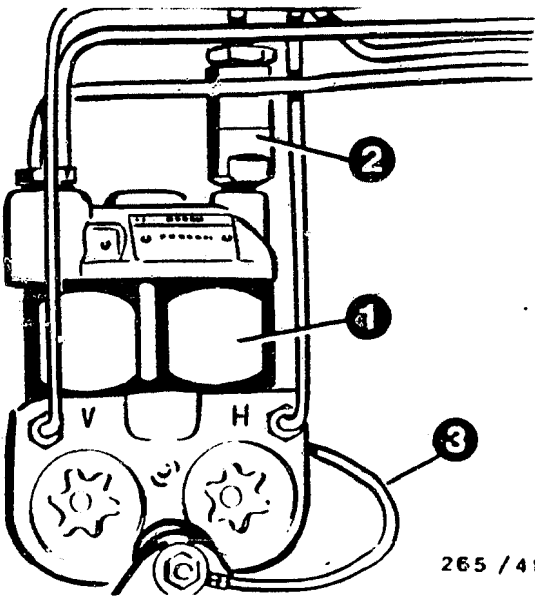
RAPID DIAGNOSIS CHART (CONTINUED)

Program-switch position 1 (3-channel hydraulic modulator)

Testing of (measurement at terminals)	Addition- al operation	Test specifi- cation (reading)	Possible causes of faults
Ground connection (term.10, term.34) Diode for warning lamp (term.29, term.32) Solenoid-operated valve internal res. (term.2, term.18, term.-, term.35) Off-position and ground connection of relay ABS warning lamp	Ignition on	6 LED (1 to 4.3) simultaneously brightly lit (top picture) ABS warning lamp in vehicle must light up	<ul style="list-style-type: none">* LED 1 and/or 2 (top picture) not lit: Check ground terminals for open circuit.* LED 3 (top picture) not lit: Diode defective, check ground connection of valve relay.* One or more LEDs 4 not lit: Check corresponding plug-in connection for solenoid-operated valve and leads.Solenoid-operated valve internal resistance 0,7...1,7 Ω* All LEDs 4 and LEDs 3 not lit: Check ground connection of valve relay, valve relay defective.* Dimmer lighting-up of an LED means contact resistance in the corresponding circuit.* ABS warning lamp not lit: Warning lamp defective. Note: all other 5 LEDs lit.



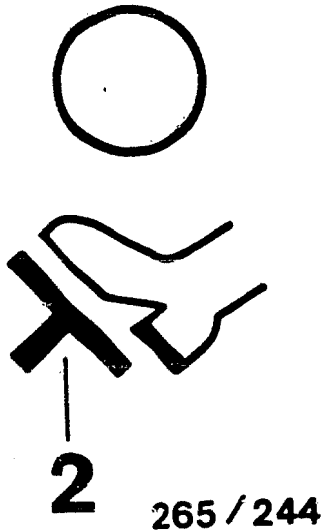
- 1 = Hydraulic modulator
- 2 = Braking-force regulator
- 3 = Ground cable



RAPID DIAGNOSIS CHART (CONTINUED)

Program-selector-switch position 2

Under test (Measurement at the terminals)	Additional operation	Test specifi- cation (reading)	Possible causes of trouble
Alternator voltage from term. 61/D+ (term. 15)	Ignition on	LED 1 (top picture) lit.	* In some cases, LED does not go out until after burst of throttle (test is O.K. in this case).
	Start engine	LED 1 (top picture) goes out when engine running	* Test lead and signal from alternator term. 61 * Alternator defective.
Stop-lamp switch (term. 25)	Ignition on	LED 2 (top picture) lit	* Stop-lamp switch defective. * Check lead to stop-lamp switch.
	Press brake pedal	LED 2 (top picture) goes out	* Lead incorrectly connected to to stop-lamp switch.



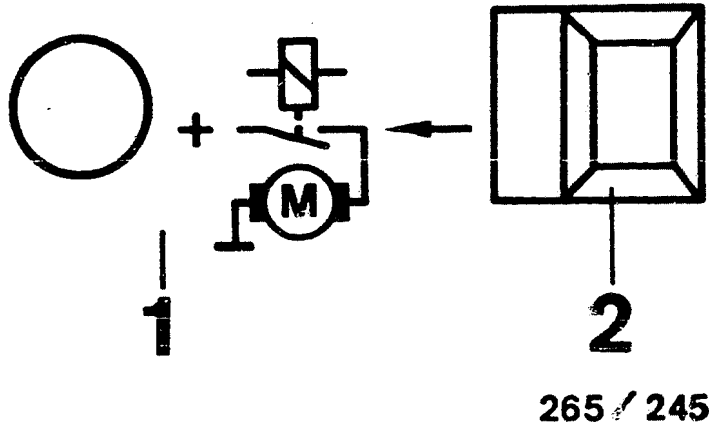
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RAPID DIAGNOSIS CHART (CONTINUED)

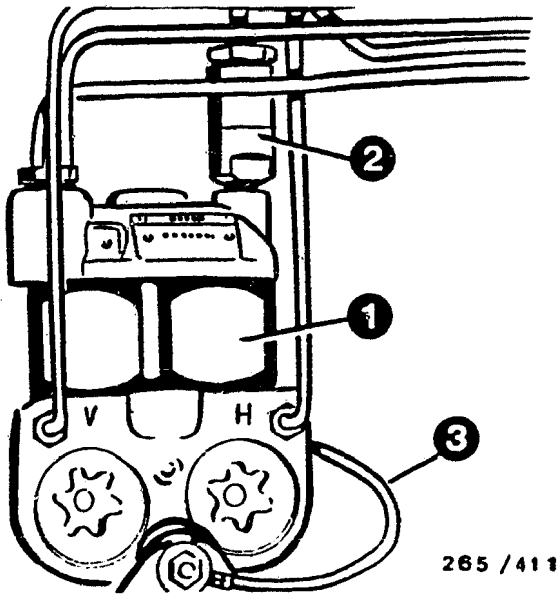
Program-selector-switch position 3

Under test (measurement at the terminals)	Additional operation	Test specifications (reading)	Possible causes of trouble
Motor relay, pump motor in hydraulic modulator (term.14 and term.28)	Ignition on, constantly press push- button 2 (upper ill- ustration)	LED 1 lights up, pump motor runs. After releasing push-button, LED stays lit due to run-on of motor (upper illustration).	<ul style="list-style-type: none">* Motor relay defective* Check frame connection and positive terminal of pump motor* Check following leads: from controller term. 14 and term. 28 to hydraulic modulator term. 9 or term. 11. Positive lead to hydraulic modulator term. 10.* Pump motor or hydraulic modulator defective.

Program-selector-switch position 4 not applicable.

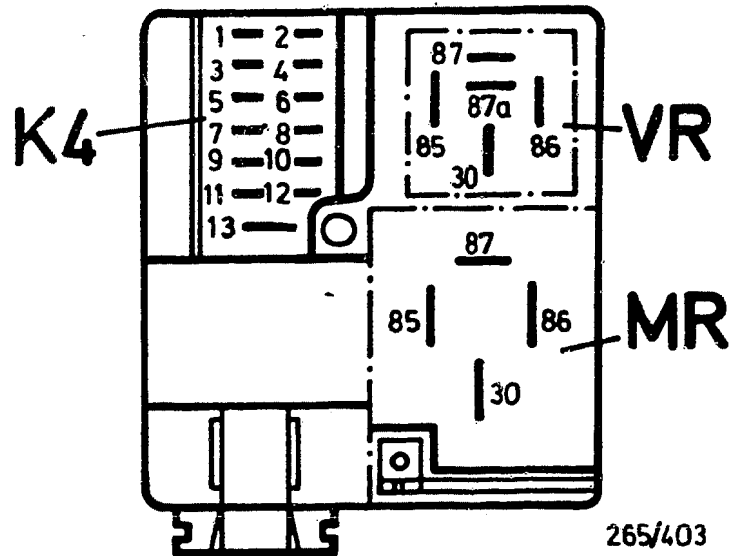
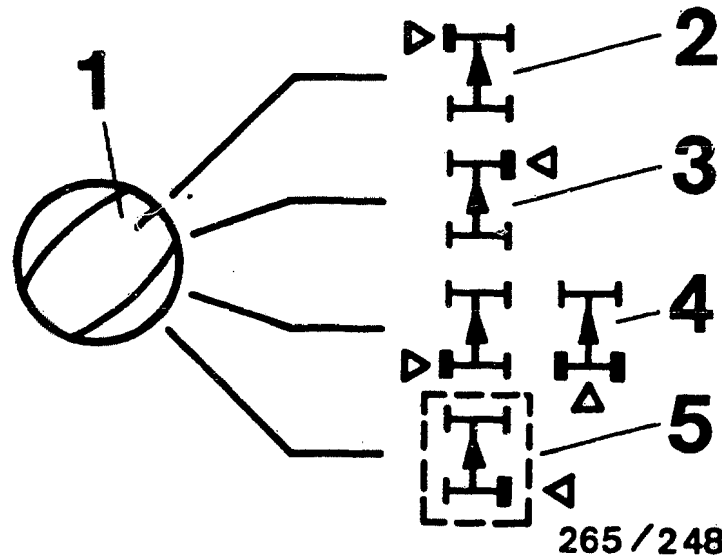
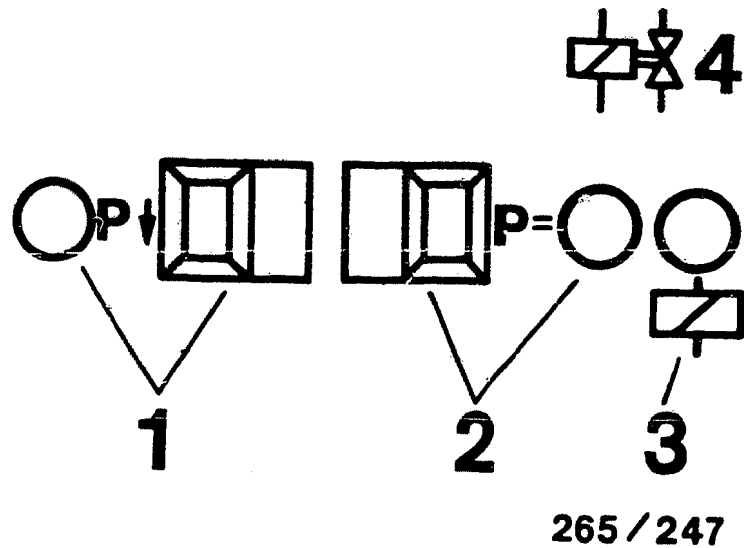


- 1 = Hydraulic modulator
- 2 = Braking-force regulator
- 3 = Ground cable



RAPID DIAGNOSIS CHART (CONTINUED)
Program-selector-switch position 5 (3-channel hydraulic modulator)

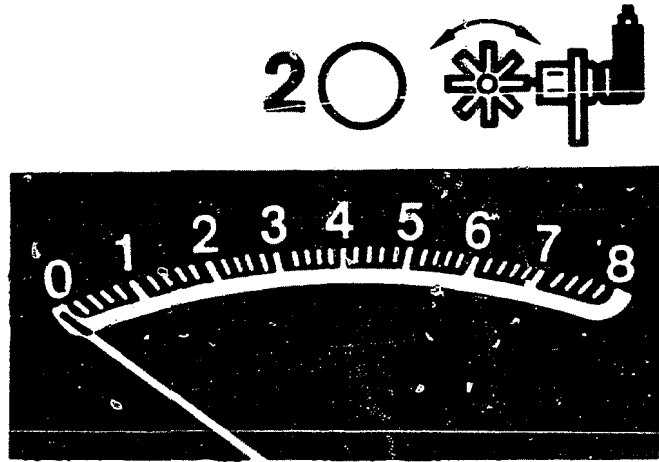
Test (measurement at terminals)	Additional operator action	Test specification (indication)	Possible fault causes
Valve-relay operation (term. 27)	Ignition on	LED 3 (upper illustration) lights up	*Valve relay (winding) or leads defective
Operation of solenoid valves in hydraulic modulator and connection correct way round. NOTE: Perform test consecutively for each wheel individually. Keep to operational sequence.	Jack up vehicle. Switch on ignition. You must be able to turn wheel under test freely by hand. Set switch 1 for wheel selection to the wheel under test. For rear axle, set to pos.4 (center illus.).		* Repeat test with engine running * Valve relay (working contact) defective * Open circuit in lead from valve relay term. 87 to B+
Pressure-holding function	1. Hold button P= (upper illus.) constantly pressed	LED P= (upper illus.) lights up	* Brake lines on hydraulic modulator mixed up * Current value not reached (LED P arrow or P= go out; upper illustration): Battery inadequately charged. Repeat test with engine running.
	2. Hold brake pedal down constantly	Wheel can be turned by hand	
	3. Release button P= (upper illus.)	LED P= goes out (upper illus.) Wheel blocked	
Pressure-reduction function	4. Press button P arrow (upper illus.)	LED P arrow (upper illus.) lights up, wheel can be turned by hand	* Electrical connections of solenoid valves correct? Wheel front left: term.2 Wheel front right: term.35 Wheel rear left: term.- Wheel rear right: term.- Rear axle: term.18 * Hydraulic modulator defective
	5. Release button P arrow (upper illus.)	LED P arrow (upper illus.) goes out, wheel blocked	
	6. Release brake pedal		



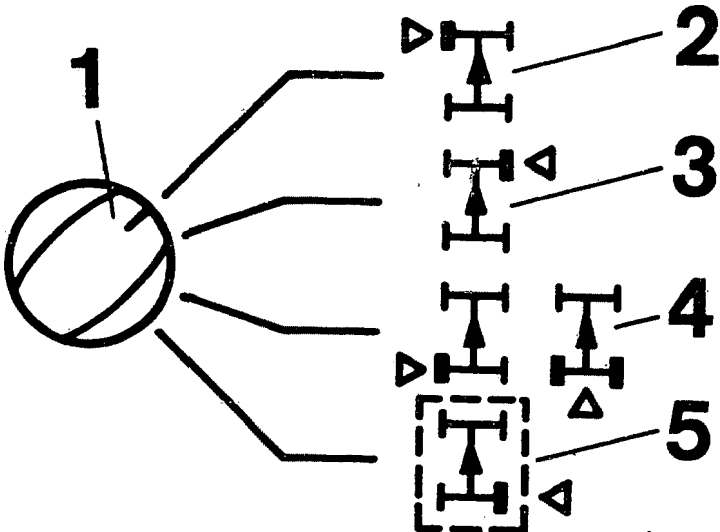
RAPID DIAGNOSIS CHART (CONTINUED)

Program-selector-switch position 6 (4 wheel-speed sensors)

Under test (measurement at the terminals)	Additional operation	Test specification (reading)	Possible causes of trouble
<p>Wheel-speed sensor for operation and mix-up</p> <p>NOTE: Check each wheel separately in turn.</p> <p>Wheel, front left: term.4 and t.6</p> <p>Wheel, front right: term.11 and term.21</p> <p>Wheel, rear left: term.8 and term.9</p> <p>Wheel, rear right: term.24 and term.26</p>	<p>Chock-up vehicle. Ignition on.</p> <p>The wheel being tested must be freely turn- able by hand.</p> <p>When testing the driven axle, the wheel not being tested must be locked.</p> <p>Set switch for wheel selection to wheel to be tested (lower illustration)</p> <p>Turn wheel by hand until LED 2 above instrument lights up without flickering. (Wheel speed approx. 1 revolution per second). Afterwards, read off indication at instrument: (upper illustration)</p>	<p>1. Smallest reading larger 1,6 divisions</p> <p>2. Permissible fluctuation max. 25 % of largest reading.</p>	<p>*Wheel-speed-sensor lead mixed up</p> <p>*Brake in wheel-speed- sensor lead</p> <p>*Wheel-speed sensor defective</p> <p>Winding resistance</p> <p>Front axle: 0,6...1,6 k Ω</p> <p>Rear axle: 0,6...1,6 k Ω</p> <p>*Air gap between wheel- speed sensor and ring gear too wide</p> <p>*Ring gear defective (e.g. corroded, dirty) or loose.</p> <p>*Ring gear with incorrect number of teeth installed</p> <p>Front axle: 45 teeth Rear axle: 45 teeth</p> <p>*Wheel-bearing clearance too large</p> <p>*Instrument gives reading, LED 2 does not light up: loose contact in wheel- speed sensor lead.</p>



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TEST SPECIFICATIONS

Wheel-speed sensor		
* Winding resistance at ambient temperature (-10°C...+120°C) for		
Front axle:	600...1500	Ω
Rear axle:	600...1600	Ω

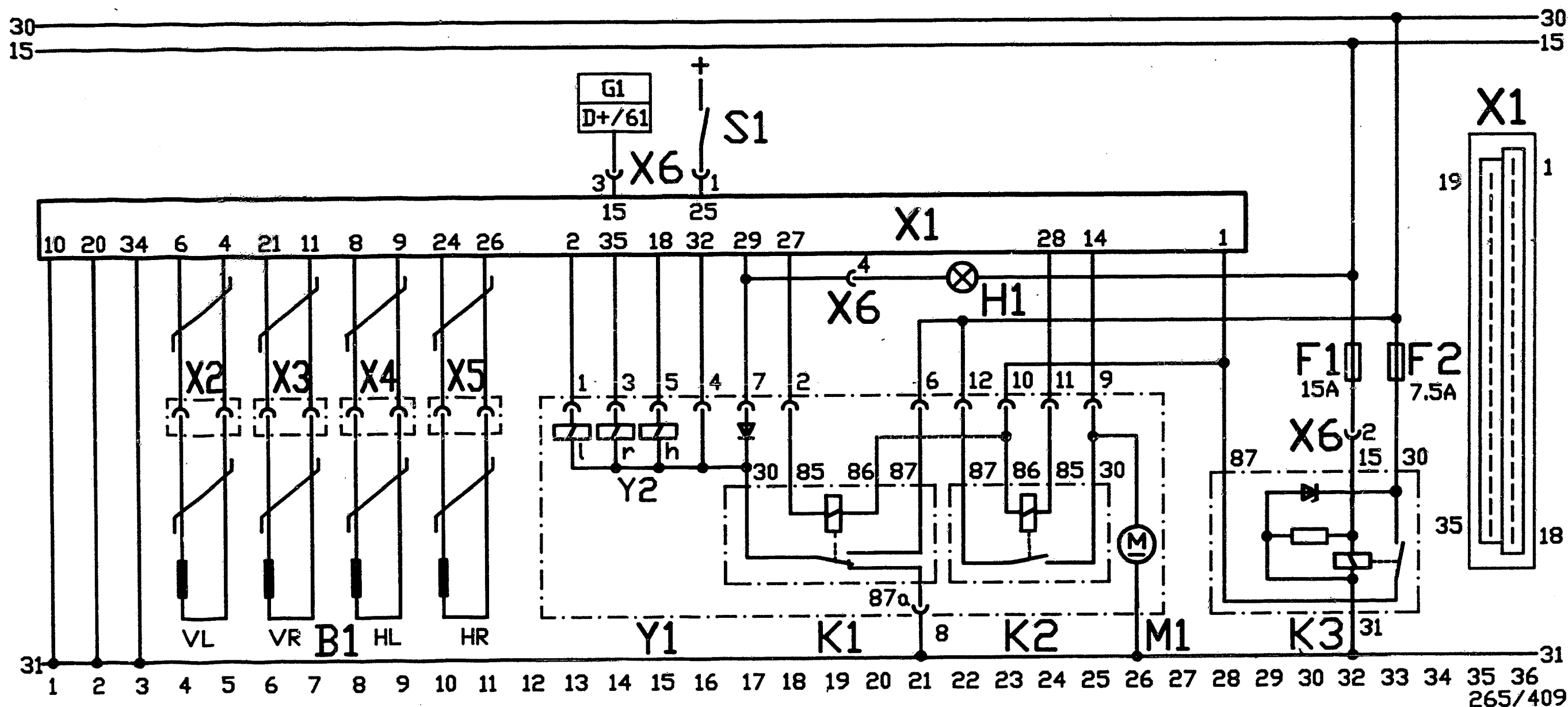
Hydraulic-modulator solenoid-operated valves		
* Winding resistance at ambient temperature (-10°C...+120°C):		
	0,7...1,7	Ω

Air gap:	0,8 ± 0,5	mm
----------	-----------	----

Tightening torque for		
* Fastening screws of wheel-speed sensors:		
	> 8	Nm
* Brake-line connections on hydraulic modulator:		
	12...16	Nm

Number of teeth		
* Front axle:	45	teeth
* Rear axle:	45	teeth

For production reasons:
continued on the following
coordinate.

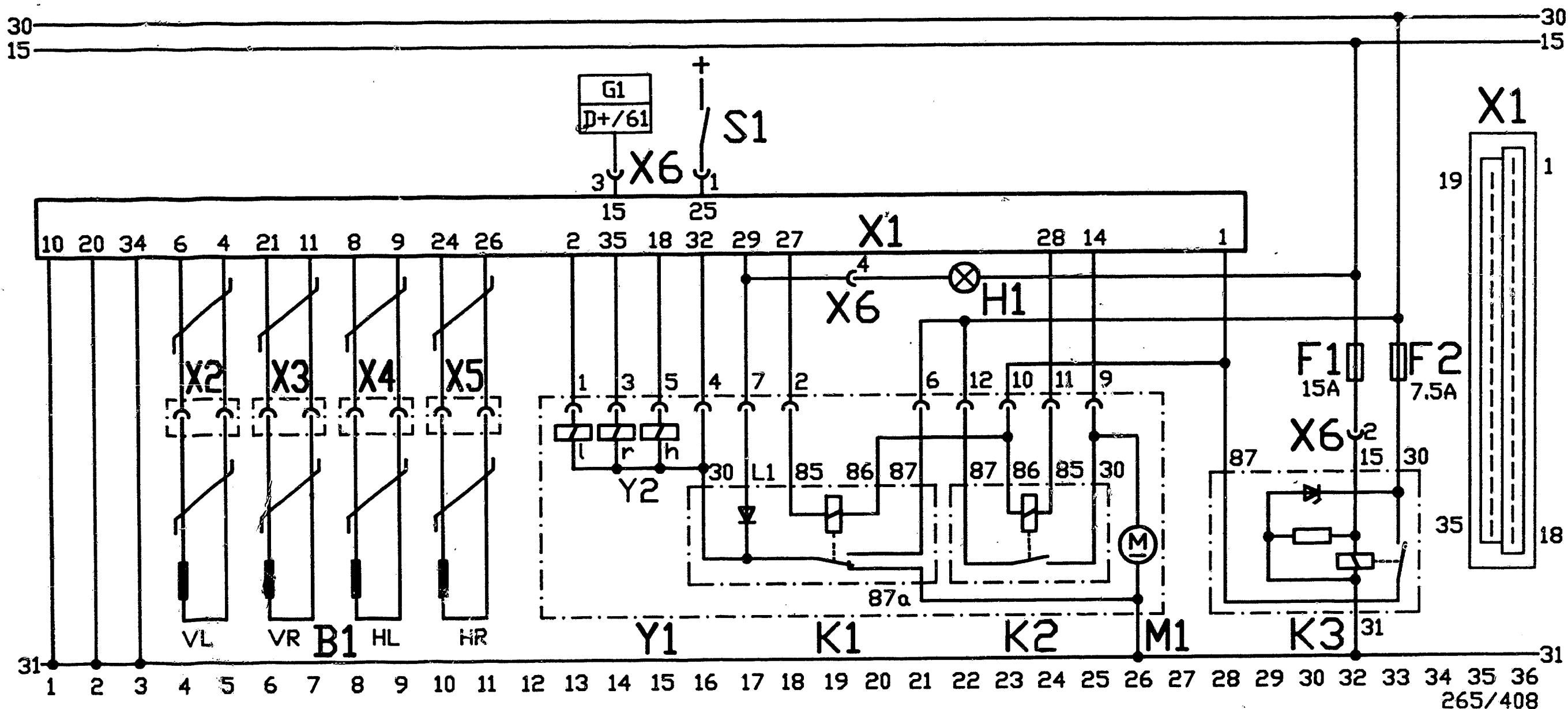


B1 = Wheel-speed sensor
 F1 = Fuse No. 19
 F2 = Fuse No. 26
 G1 = To alternator
 H1 = ABS warning lamp
 in instrument cluster
 K1 = Valve relay
 K2 = Motor relay

K3 = Overvoltage-protection
 relay
 M1 = Return-supply-pump motor
 S1 = Stop-lamp switch
 X1 = Controller plug (35-pin)
 X2...X5 = Wheel-speed-sensor plug
 X6 = 4-pin plug in
 central electrics

Y1 = Hydraulic modulator
 Y2 = Solenoid-operated valves
 HL = Rear left
 HR = Rear right
 h = Rear axle
 VL = l = Front left
 VR = r = Front right

ELECTRICAL TERMINAL DIAGRAM -> 08.1987

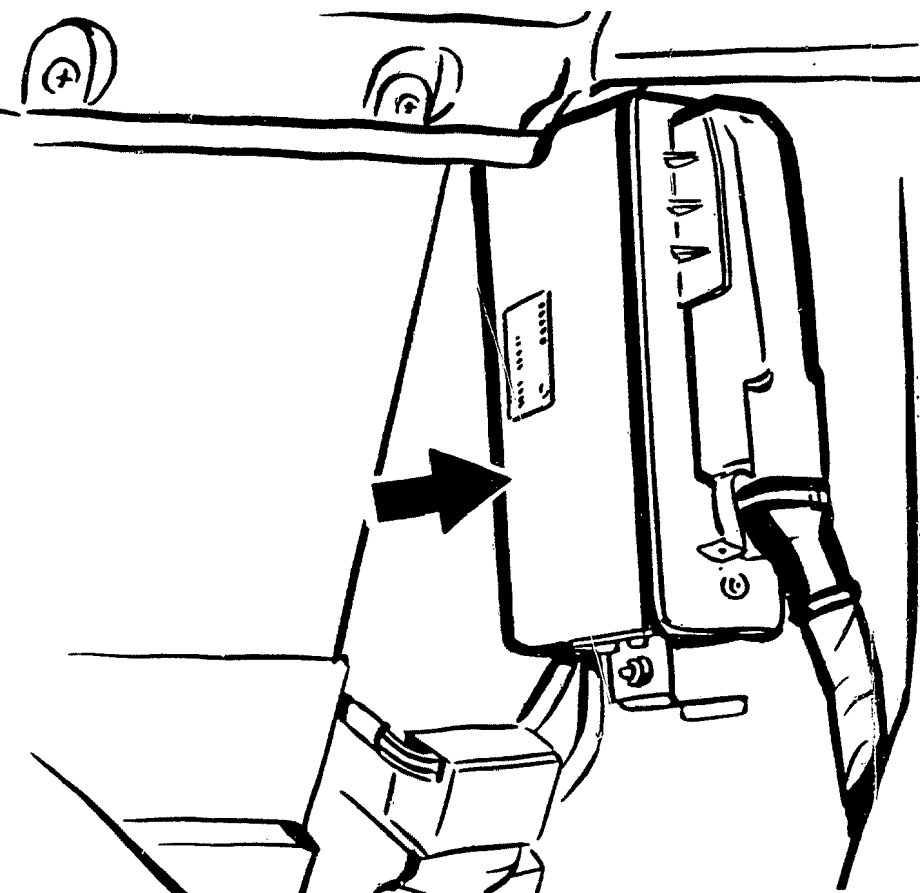


B1 = Wheel-speed sensor
 F1 = Fuse No. 19
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 relay
 M1 = Return-supply-pump motor
 S1 = Stop-lamp switch
 X1 = Controller plug (35-pin)
 X2...X5 = Wheel-speed-sensor plug
 X6 = 4-pin plug in
 central electrics

Y1 = Hydraulic modulator
 Y2 = Solenoid-operated valves
 HL = Rear left
 HR = Rear right
 h = Rear axle
 VL = l = Front left
 VR = r = Front right

ELECTRICAL TERMINAL DIAGRAM 09.1987->



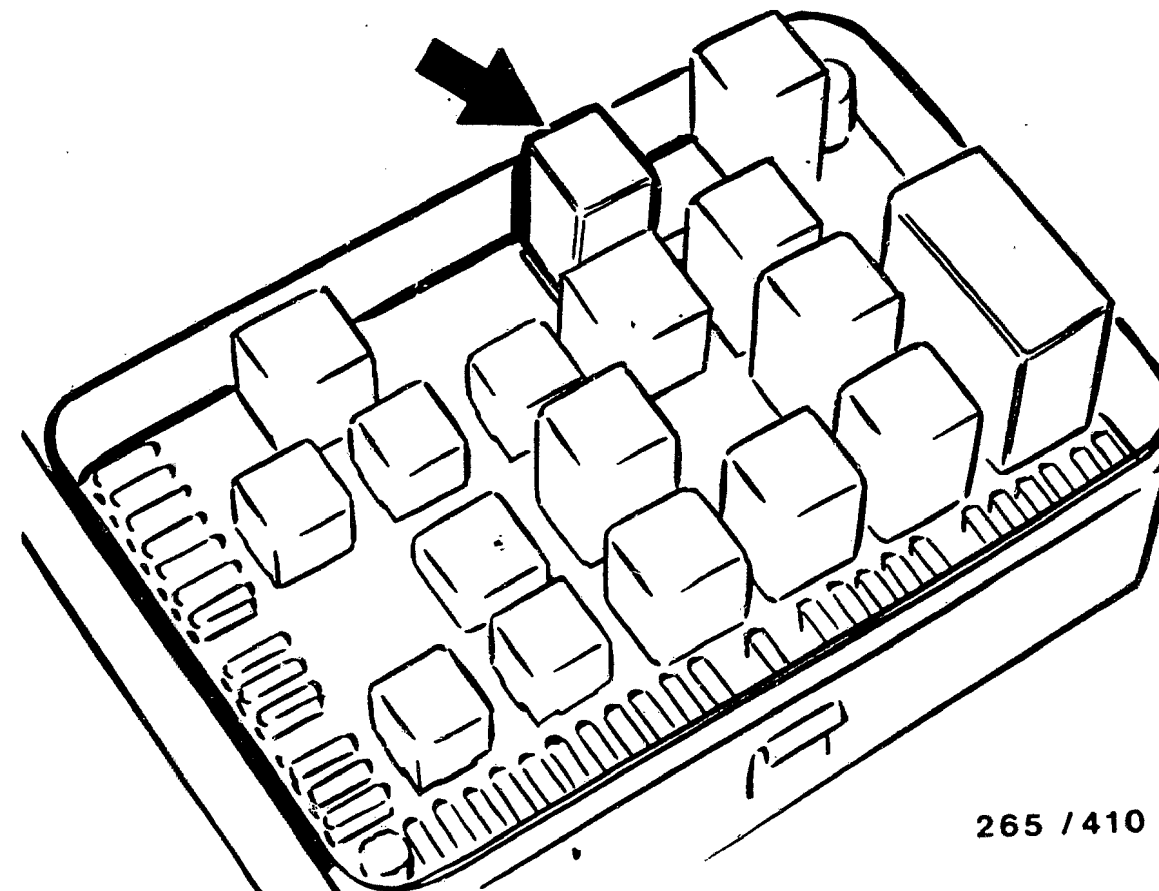
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Arrow = ABS controller

INSTALLATION POSITION OF COMPONENTS

The indications "right" and "left" always refer to the forward direction of travel.

- * Controller:
in the passenger-side footwell on the right.
Remove panelling.
- * ABS warning lamp:
in the instrument cluster.
- * Stop-lamp switch:
on the brake pedal.

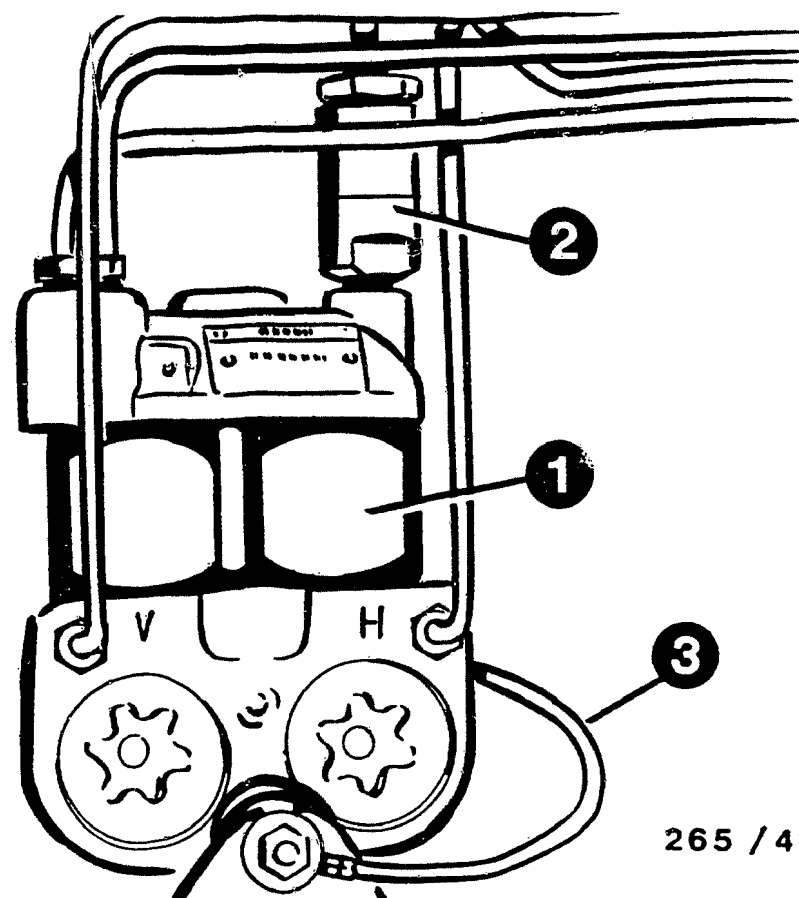


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Arrow = Overvoltage-protection relay

INSTALLATION POSITION OF COMPONENTS (Continued)

- * Overvoltage-protection relay:
in the central electrics.
- * ABS fuse:
No. 26 (7.5A) in the central electrics.
- * Ground terminals:
ground bolt at control unit,
ground cable on hydraulic modulator,
ground terminal of overvoltage-protection relay
beneath the central electrics.



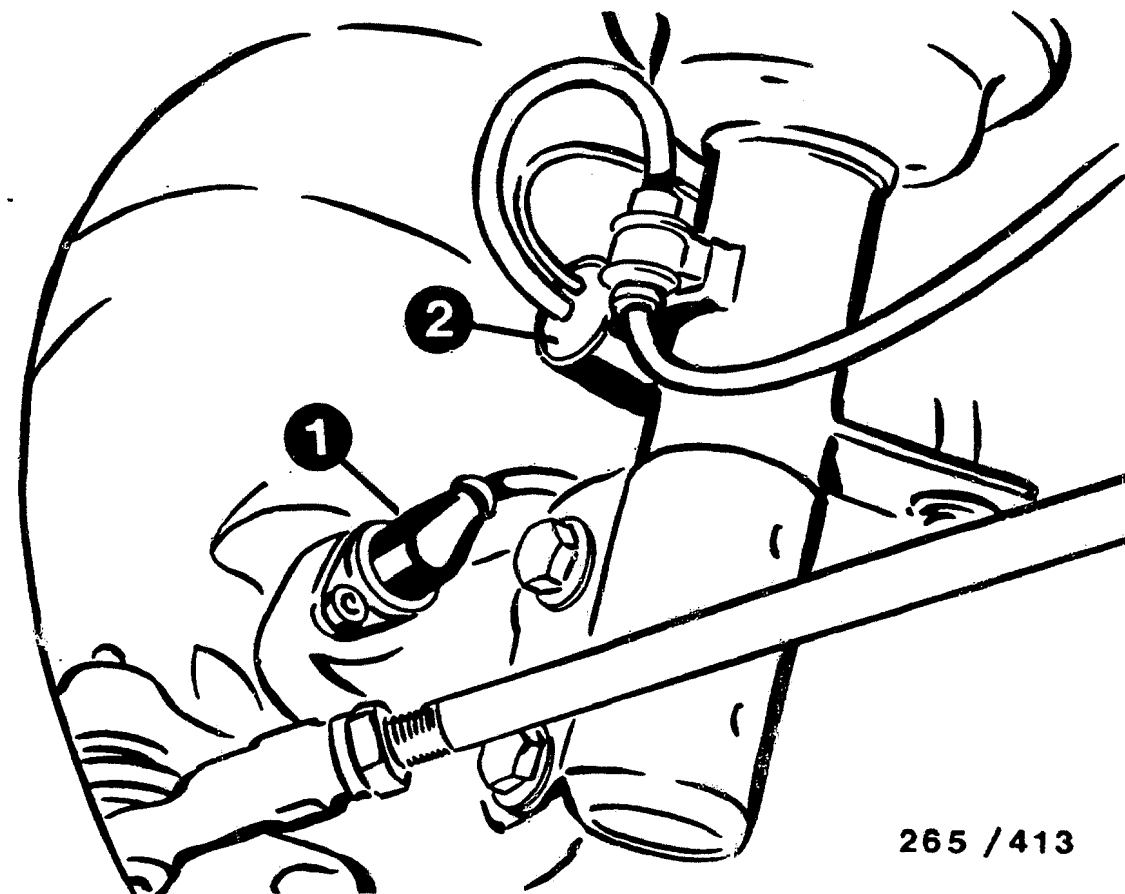
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- 1 = Hydraulic modulator
- 2 = Braking-force regulator
- 3 = Ground cable

INSTALLATION POSITION OF COMPONENTS (Continued)

- * Hydraulic modulator:
in the front right wheel house on the rear
side behind the cover.
The hydraulic modulator must not be repaired,
but be exchanged as a complete unit.
Exception: relays may be changed.

Make sure that the brake-line connections
are assigned correctly.

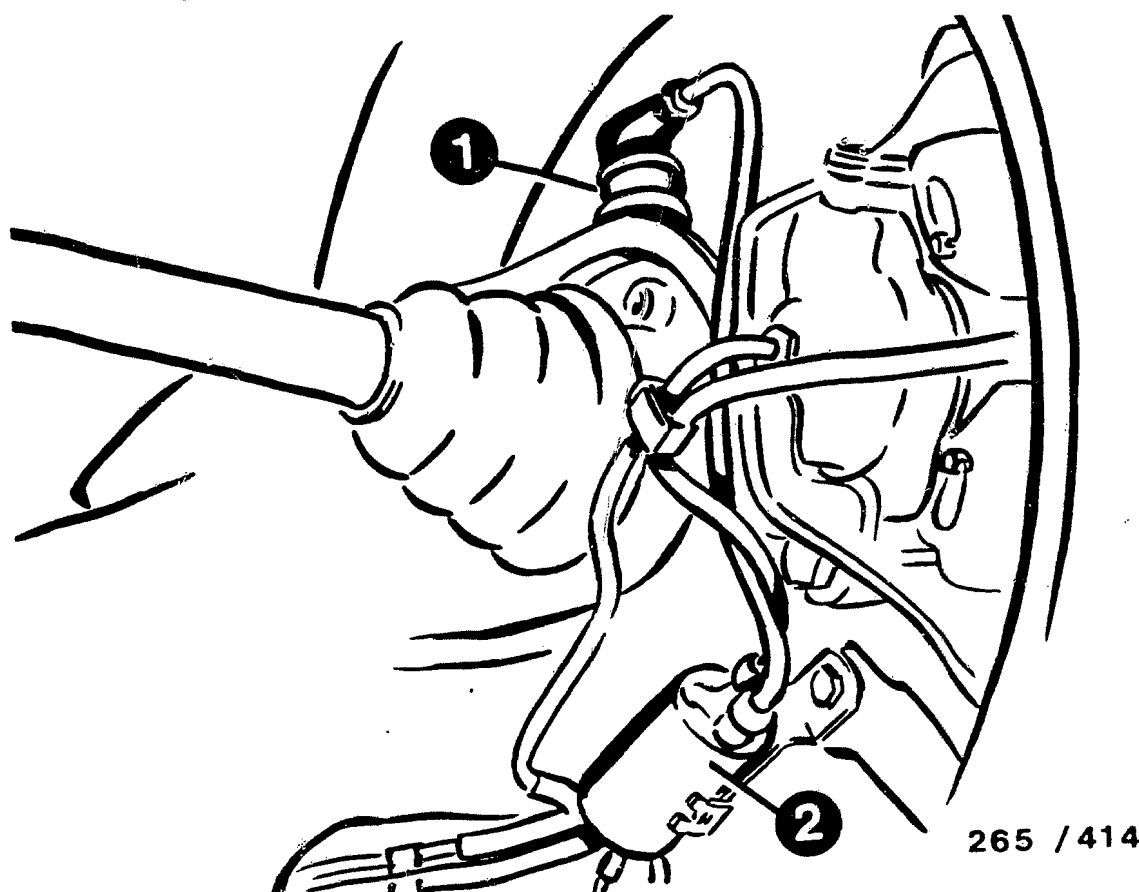


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- 1 = Wheel-speed sensors, front
- 2 = Plug for wheel-speed-sensor and
brake-lining-wear lead

INSTALLATION POSITION OF COMPONENTS (Continued)

- * Wheel-speed sensors (cross pole), front axle:
one on each side in the steering knuckles.



- 1 = Wheel speed sensors, rear
 2 = Plug for wheel-speed sensor and brake-lining-wear lead

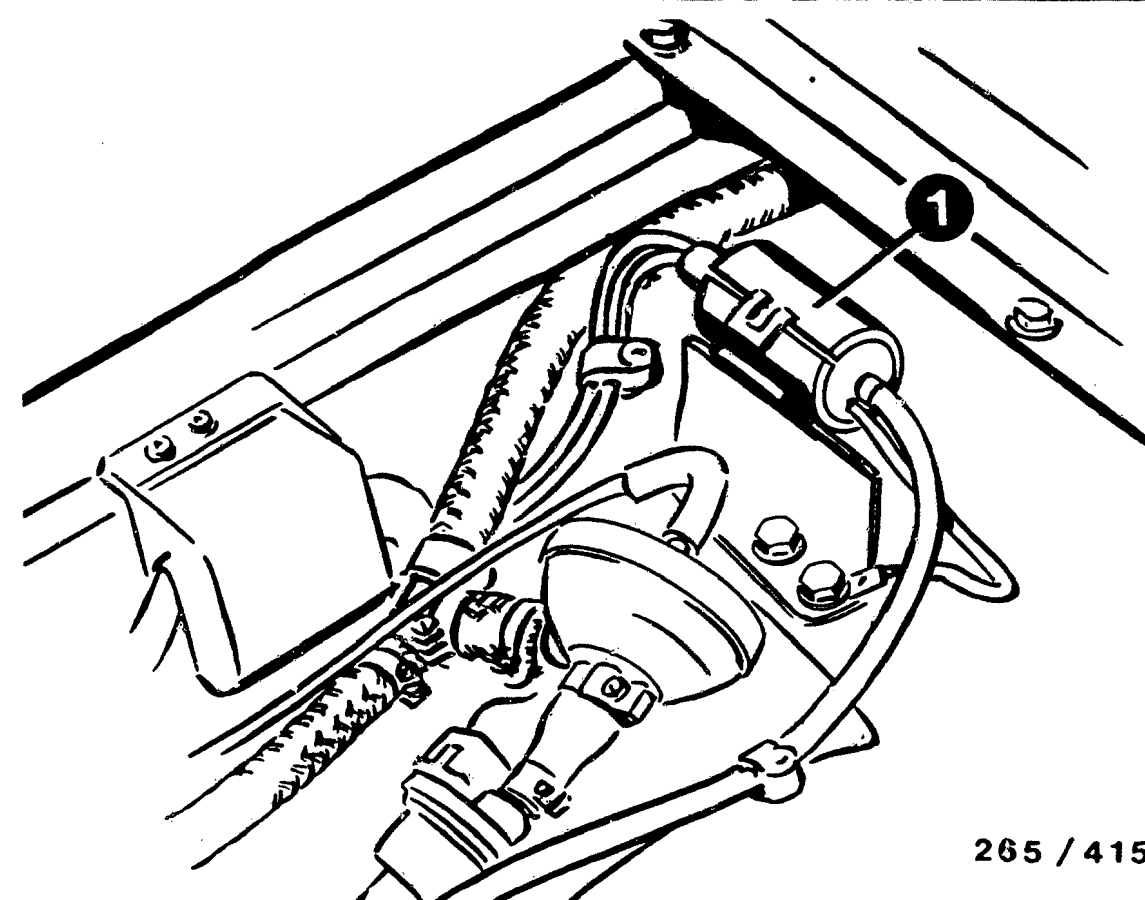
INSTALLATION POSITION OF COMPONENTS (Continued)

- * Wheel-speed sensors, rear axle:
 one on each side in the rear axle link.

Wheel-speed-sensor plug-in connections: the plug-in connections for the wheel-speed sensors and brake-lining-wear sensors are located in a common plug housing.

Each sensor is connected to the control unit via 2 plug-in connections.

The plug-in connections are moisture-resistant and clearly differentiated so that it is impossible to mix up the wheel-speed-sensor lead and the brake-lining lead.



- 1 = Wheel-speed-sensor plug-in connection in engine compartment

INSTALLATION POSITION OF COMPONENTS (Continued)

Plug-in connections are clipped into a sheet-metal mounting.

- * Wheel-speed-sensor plug-in connections, front axle:
 one plug-in connection near to the wheel-speed sensor at the lower end of the McPherson strut, the second plug-in connection in the engine compartment.
- * Wheel-speed-sensor plug-in connections, rear axle:
 one plug-in connection near to the wheel-speed sensor on the rear axle link, the second plug-in connection on the underbody.

Trouble-shooting instructions : POR-5013

BOSCH system : ABS

Make of vehicle : PORSCHE

Basic microcard : KFZ-00..

TABLE OF CONTENTS

Section	Coordinates
Special features	02
Structure, usage	02
Safety and precautionary measures	02
Test requirements	03
Rapid diagnosis chart	05
Test specifications	17
Electrical terminal diagram	19
Installation position of components, notes on removal and installation	21

SPECIAL FEATURES

This microcard, valid at the time of publication, contains trouble-shooting instructions for the following models:

PORSCHE 928 S
08.1987 ->

- * ABS with 4 wheel-speed sensors and 3 hydraulic channels.
- * Sensor ring gear with 45 teeth.
- * Vehicles with tire-inflation-pressure monitoring system (RKS) are provided with wheel-speed-sensor signals conditioned by the ABS controller. Refer to SIS for RKS for testing these signals.

STRUCTURE, USAGE

These brief instructions encompass essentially vehicle-specific special features and test specifications (set values).

For a detailed description of trouble-shooting, see the basic instructions.

ATTENTION :
The set values, terminal assignments and special features of these vehicle-specific brief instructions are always binding.

SAFETY AND PRECAUTIONARY MEASURES

- * For safety reasons, the hydraulic modulator must not be repaired, but be exchanged as a complete unit.
Exception: relays.
- * Do not loosen any screws on the hydraulic modulator!
Danger of fatal accident due to brake failure.
- * Caution when handling brake fluid.
Poisonous!

For further information, see basic instructions.

TEST REQUIREMENTS FOR TESTING WITH ABS2 LED TESTER

- * Regulatory tire size fitted?
- * Check for firm seating of ground of return-supply pump.
- * Check for firm seating and corrosion of ground of overvoltage-protection relay term. 31.
- * Check for firm seating of ground strap between engine block and vehicle frame.
- * Check for leaks in hydraulic connections at hydraulic modulator and sealing points (visual examination).
- * If the ABS warning lamp lights up intermittently when driving (e.g. after switching on loads) and goes out again by itself, check the battery and power supply (alternator, regulator and voltage drops).
- * If the ABS warning lamp lights up constantly and does not go out, check the following points:
 - Controller plug sitting correctly on controller and latched?
 - All plug contacts O.K.?
 - Spring contacts latched?
 - Check installation position for correct seating of seal ring in controller plug, rounded side downward.

- Check wheel-speed-sensor leads for correct assignment at controller plug:

Wheel-speed sensors:

front left to term. 6 and term. 4.
front right to term. 11 and term. 21.
rear left to term. 8 and term. 9.
rear right to term. 24 and term. 26.
rear axle to term. — and term. —.

- V-belt snapped?
(Alternator provides no voltage, charge-indicator lamp and ABS warning lamp light up).
- * Connect ABS 2 LED tester to ABS wiring harness.
- Disconnect and connect controller only with ignition switched off.
- For testing, switch on ignition in all program-selector-switch positions (tester operates with current supply from vehicle battery).
- Observe LED (green) for current supply in all program-selector-switch positions.

C A U T I O N !

Do not drive with tester connected!

The brake system must be bled of air before the ABS test. Do not activate the ABS tester while the system is being bled.

Repeat the complete test program after any repairs are carried out.

The Antiskid System is a vehicle safety system.

Work on the system demands detailed knowledge of the system.

The conventional brake system must be O.K.

General information for trouble-shooting:

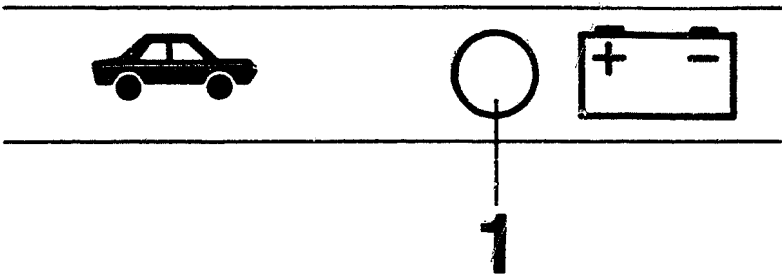
Check all leads for short circuit to ground and contact with positive leads and watch out for worn cable insulation and pinched leads.

RAPID DIAGNOSIS CHART

Never drive with tester connected! Have all test prerequisites been met?

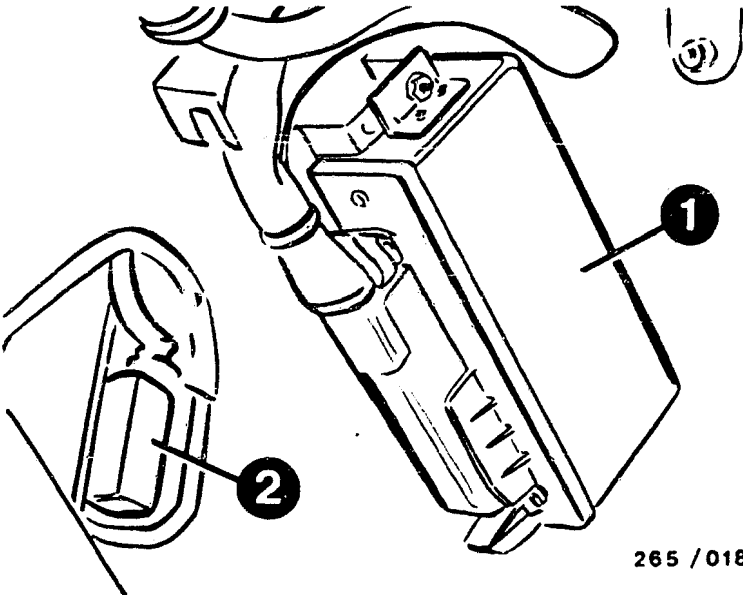
Program-selector-switch settings 1 - 6

Testing of (measurement at terminals)	Additional operation	Test speci- fication (indication)	Possible causes of trouble
Voltage supply (Term.1 and term.20)	Ignition on	LED 1 (top picture) lights up constantly	<ul style="list-style-type: none">* Fuse defective.* Inadequate battery charge.* Excessive voltage dips.* Check leads from relay plug to controller term. 1, to driving switch term. 15, to battery B+ and to ground terminal. Check ground lead to controller term. 20.* Over-voltage protection relay defective.



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1 = ABS controller
2 = Hood release mechanism

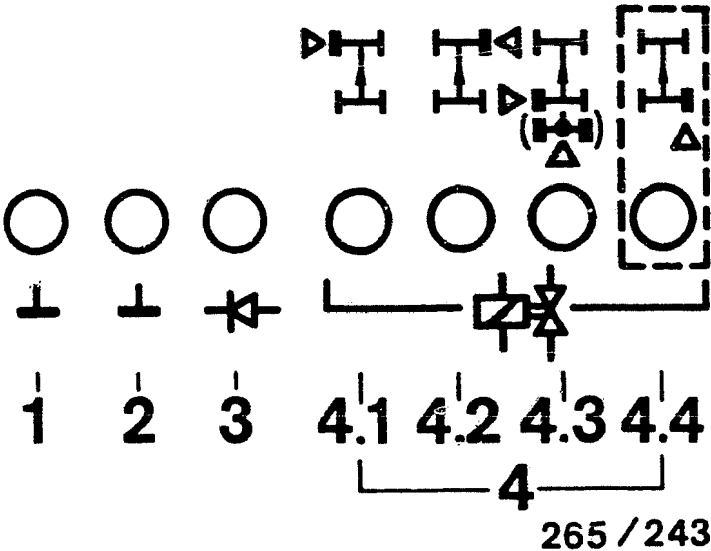


265 / 0189

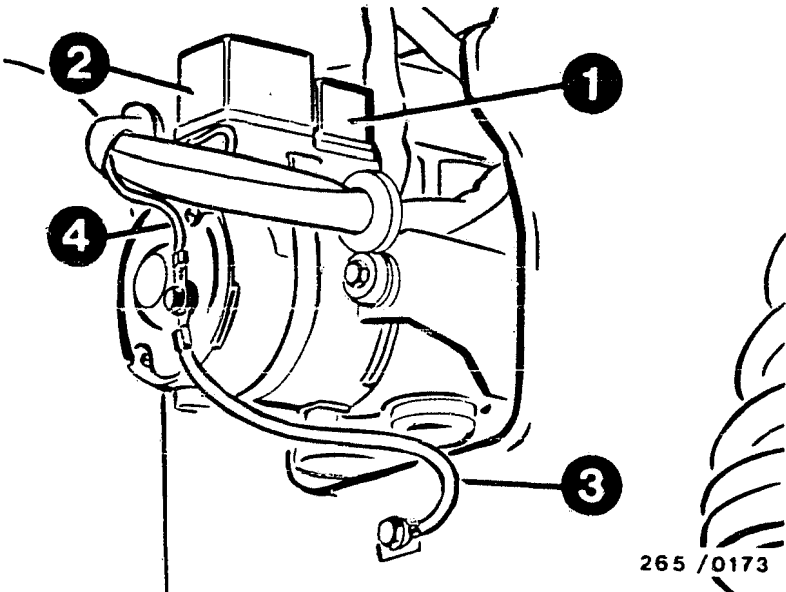
RAPID DIAGNOSIS CHART (CONTINUED)

Program-switch position 1 (3-channel hydraulic modulator)

Testing of (measurement at terminals)	Addition- al operation	Test specifi- cation (reading)	Possible causes of faults
Ground connection (term.10, term.34) Diode for warning lamp (term.29, term.32) Solenoid-operated valve internal res. (term.2, term.18, term.-, term.35) Off-position and ground connection of relay ABS warning lamp	Ignition on	6 LED (1 to 4.3) simultaneously brightly lit (top picture) ABS warning lamp in vehicle must light up	<ul style="list-style-type: none">* LED 1 and/or 2 (top picture) not lit: Check ground terminals for open circuit.* LED 3 (top picture) not lit: Diode defective, check ground connection of valve relay.* One or more LEDs 4 not lit: Check corresponding plug-in connection for solenoid- operated valve and leads.Solenoid-operated valve internal resistance 0,7...1,7 Ω* All LEDs 4 and LEDs 3 not lit: Check ground connection of valve relay, valve relay defective.* Dimmer lighting-up of an LED means contact resistance in the corresponding circuit.* ABS warning lamp not lit: Warning lamp defective. Note: all other 5 LEDs lit.



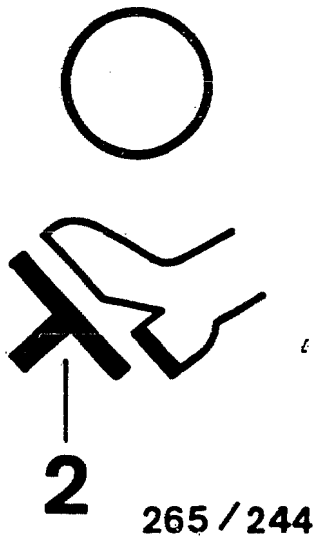
- 1 = Valve relay
- 2 = Motor relay
- 3 = Ground connection, return pump
- 4 = Ground connection, valve relay
(if provided).



RAPID DIAGNOSIS CHART (CONTINUED)

Program-selector-switch position 2

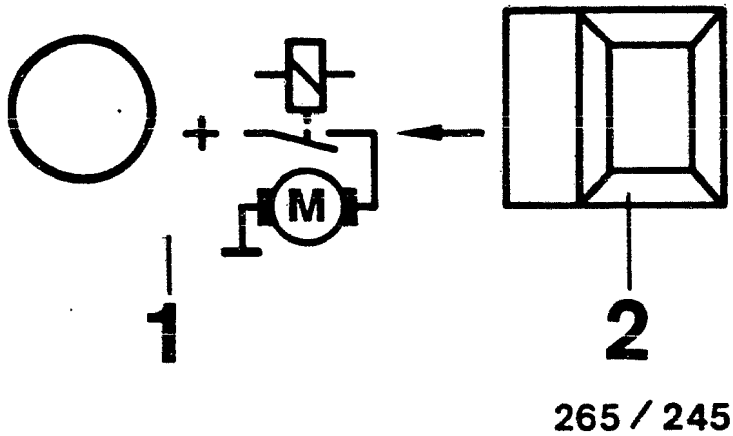
Under test (Measurement at the terminals)	Addition- al operation	Test specifi- cation (reading)	Possible causes of trouble
Alternator voltage from term. 61/D+ (term. 15)	Ignition on	LED 1 (top picture) lit.	* In some cases, LED does not go out until after burst of throttle (test is O.K. in this case).
	Start engine	LED 1 (top picture) goes out when engine running	* Test lead and signal from alternator term. 61 * Alternator defective.
Stop-lamp switch (term. 25)	Ignition on	LED 2 (top picture) lit	* Stop-lamp switch defective. * Check lead to stop-lamp switch.
	Press brake pedal	LED 2 (top picture) goes out	* Lead incorrectly connected to to stop-lamp switch.



RAPID DIAGNOSIS CHART (CONTINUED)

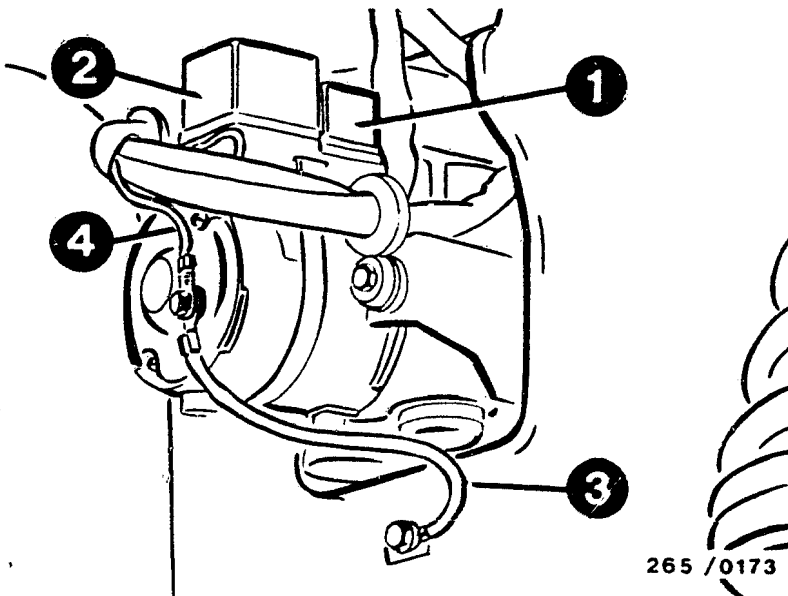
Program-selector-switch position 3

Under test (measurement at the terminals)	Additional operation	Test specification (reading)	Possible causes of trouble
Motor relay, pump motor in hydraulic modulator (term.14 and term.28)	Ignition on, press button 2 contin- uously (top picture)	LED 1 lights up, pump motor runs. After releasing button, LED con- tinues to light due to run-on of motor (top picture).	<ul style="list-style-type: none">* Motor relay defective* Test ground connection and positive terminal of pump motor* Test following leads: From controller term. 14 and term. 28 to hydraulic modulator term. 9 or term. 11. Positive leads to hydraulic modulator term. 10 and term. 12.* Pump motor or hydraulic modulator defective.



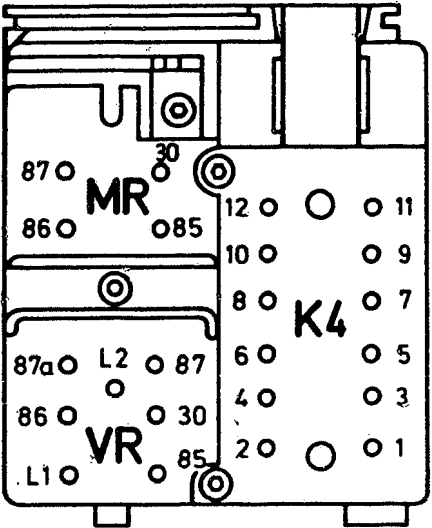
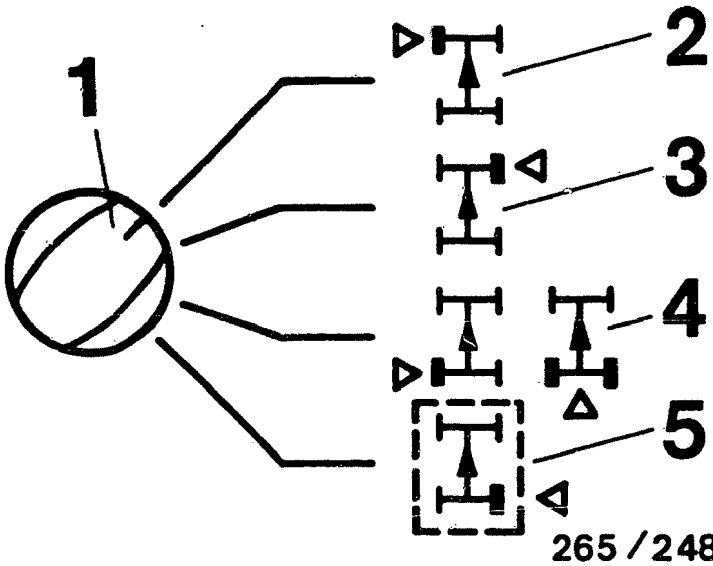
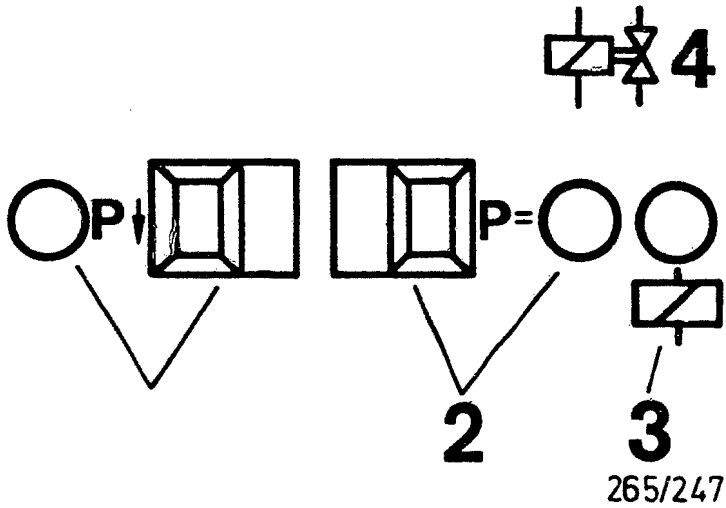
- 1 = Valve relay
2 = Motor relay
3 = Ground connection, return pump
4 = Ground connection, valve relay (if provided).

Program-selector-switch position 4 does not apply.



RAPID DIAGNOSIS CHART (CONTINUED)
Program-selector-switch position 5 (3-channel hydraulic modulator)

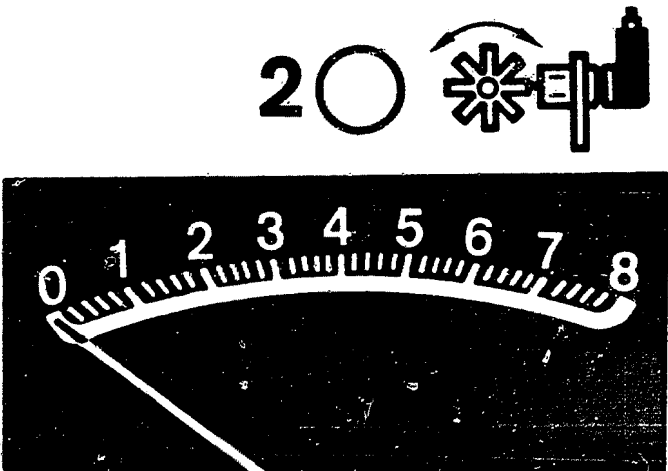
Test (measurement at terminals)	Additional operator action	Test specification (indication)	Possible fault causes
Valve-relay operation (term. 27)	Ignition on	LED 3 (upper illustration) lights up	*Valve relay (winding) or leads defective
Operation of solenoid valves in hydraulic modulator and connection correct way round. NOTE: Perform test consecutively for each wheel individually. Keep to operational sequence.	Jack up vehicle. Switch on ignition. You must be able to turn wheel under test freely by hand. Set switch 1 for wheel selection to the wheel under test. For rear axle, set to pos.4 (center illus.).		* Repeat test with engine running * Valve relay (working contact) defective * Open circuit in lead from valve relay term. 87 to B+
Pressure-holding function	1. Hold button P= (upper illus.) constantly pressed	LED P= (upper illus.) lights up	* Brake lines on hydraulic modulator mixed up * Current value not reached (LED P arrow or P= go out; upper illustration); Battery inadequately charged. Repeat test with engine running.
	2. Hold brake pedal down constantly	Wheel can be turned by hand	
	3. Release button P= (upper illus.)	LED P= goes out (upper illus.) Wheel blocked	
Pressure-reduction function	4. Press button P arrow (upper illus.)	LED P arrow (upper illus.) lights up, wheel can be turned by hand	* Electrical connections of solenoid valves correct? Wheel front left: term.2 Wheel front right: term.35 Wheel rear left: term.- Wheel rear right: term.- Rear axle: term.18 * Hydraulic modulator defective
	5. Release button P arrow (upper illus.)	LED P arrow (upper illus.) goes out, wheel blocked	
	6. Release brake pedal		



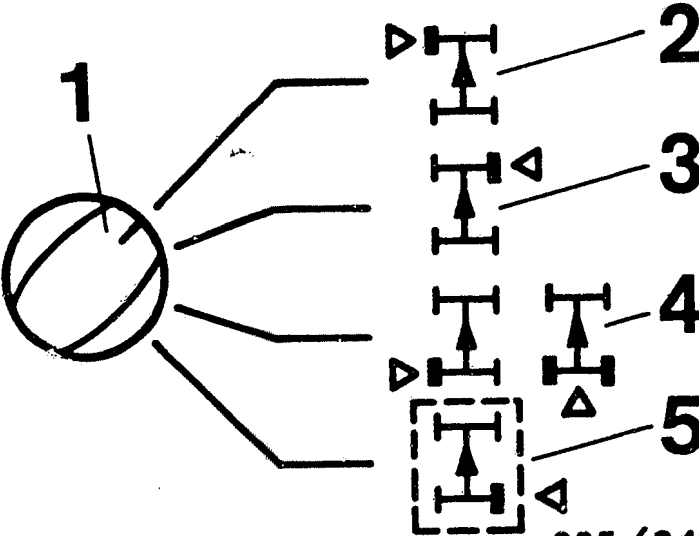
RAPID DIAGNOSIS CHART (CONTINUED)

Program-selector-switch position 6 (4 wheel-speed sensors)

Under test (measurement at the terminals)	Additional operation	Test specification (reading)	Possible causes of trouble
<p>Wheel-speed sensor for operation and mix-up</p> <p>NOTE: Check each wheel separately in turn.</p> <p>Wheel, front left: term.4 and t.6</p> <p>Wheel, front right: term.11 and term.21</p> <p>Wheel, rear left: term.8 and term.9</p> <p>Wheel, rear right: term.24 and term.26</p>	<p>Chock-up vehicle. Ignition on.</p> <p>The wheel being tested must be freely turn- able by hand.</p> <p>When testing the driven axle, the wheel not being tested must be locked.</p> <p>Set switch for wheel selection to wheel to be tested (lower illustration)</p> <p>Turn wheel by hand until LED 2 above instrument lights up without flickering. (Wheel speed approx. 1 revolution per second). Afterwards, read off indication at instrument: (upper illustration)</p>	<p>1. Smallest reading larger 1,6 divisions</p> <p>2. Permissible fluctuation max. 25 % of largest reading.</p>	<p>*Wheel-speed-sensor lead mixed up</p> <p>*Brake in wheel-speed- sensor lead</p> <p>*Wheel-speed sensor defective</p> <p>Winding resistance Front axle: 0,6...1,6 k Ω</p> <p>Rear axle: 0,6...1,6 k Ω</p> <p>*Air gap between wheel- speed sensor and ring gear too wide</p> <p>*Ring gear defective (e.g. corroded, dirty) or loose.</p> <p>*Ring gear with incorrect number of teeth installed Front axle: 45 teeth Rear axle: 45 teeth</p> <p>*Wheel-bearing clearance too large</p> <p>*Instrument gives reading, LED 2 does not light up: loose contact in wheel- speed sensor lead.</p>



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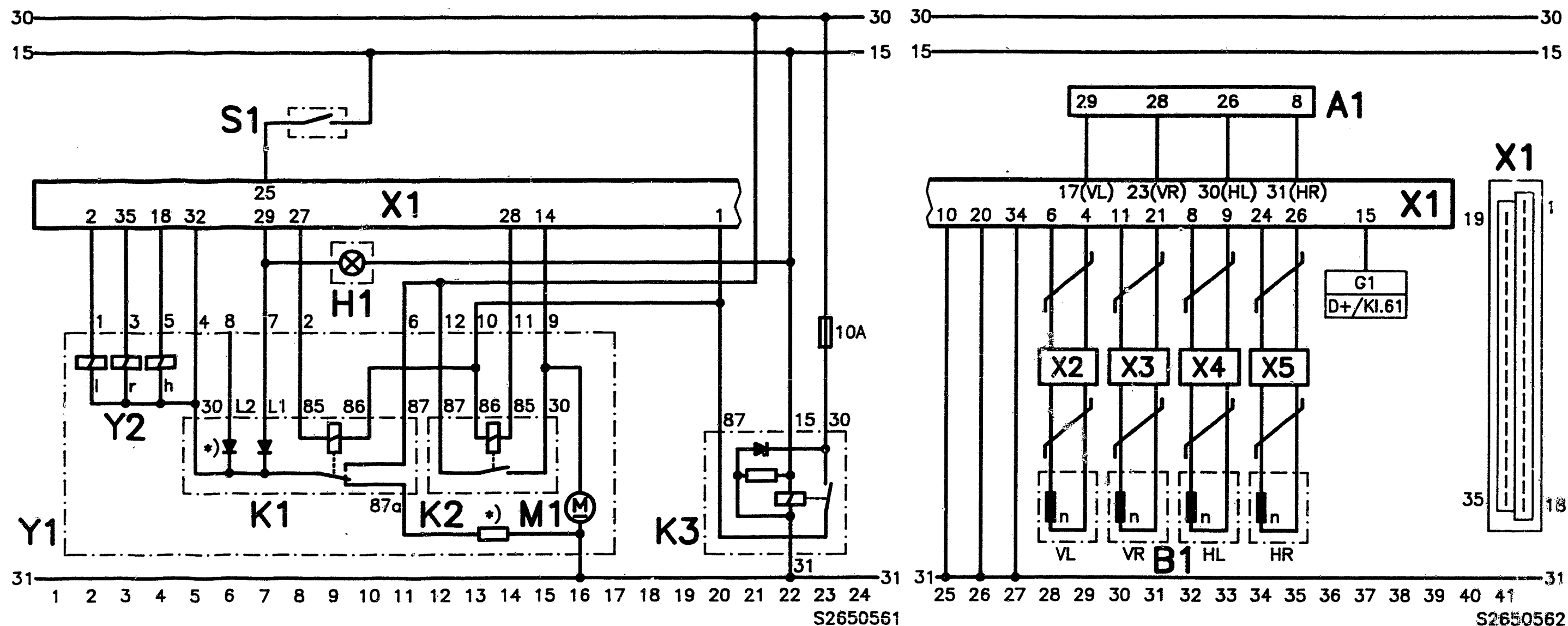


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TEST SPECIFICATIONS

Wheel-speed sensor		
* Winding resistance at ambient temperature (-10°C...+120°C) for front wheels:	600...1600	Ω
rear wheels:	600...1600	Ω
Hydraulic-modulator solenoid valves		
* Winding resistance at ambient temperature (-10°C...+120°C):	0,7...1,7	Ω
Air gap between wheel-speed sensor and ring gear		
* at front wheels:	0,8 ± 0,5	mm
* at rear wheels:	0,8 ± 0,5	mm
Tightening torque for		
* fastening screws of wheel-speed sensors:	> 8	Nm
* Brake-line connections at hydraulic modulator:	12...16	Nm
Number of teeth on ring gears of wheel-speed sensors		
* at front wheels:	45	teeth
* at rear wheels:	45	teeth

For production reasons:
continued on the following
coordinate.

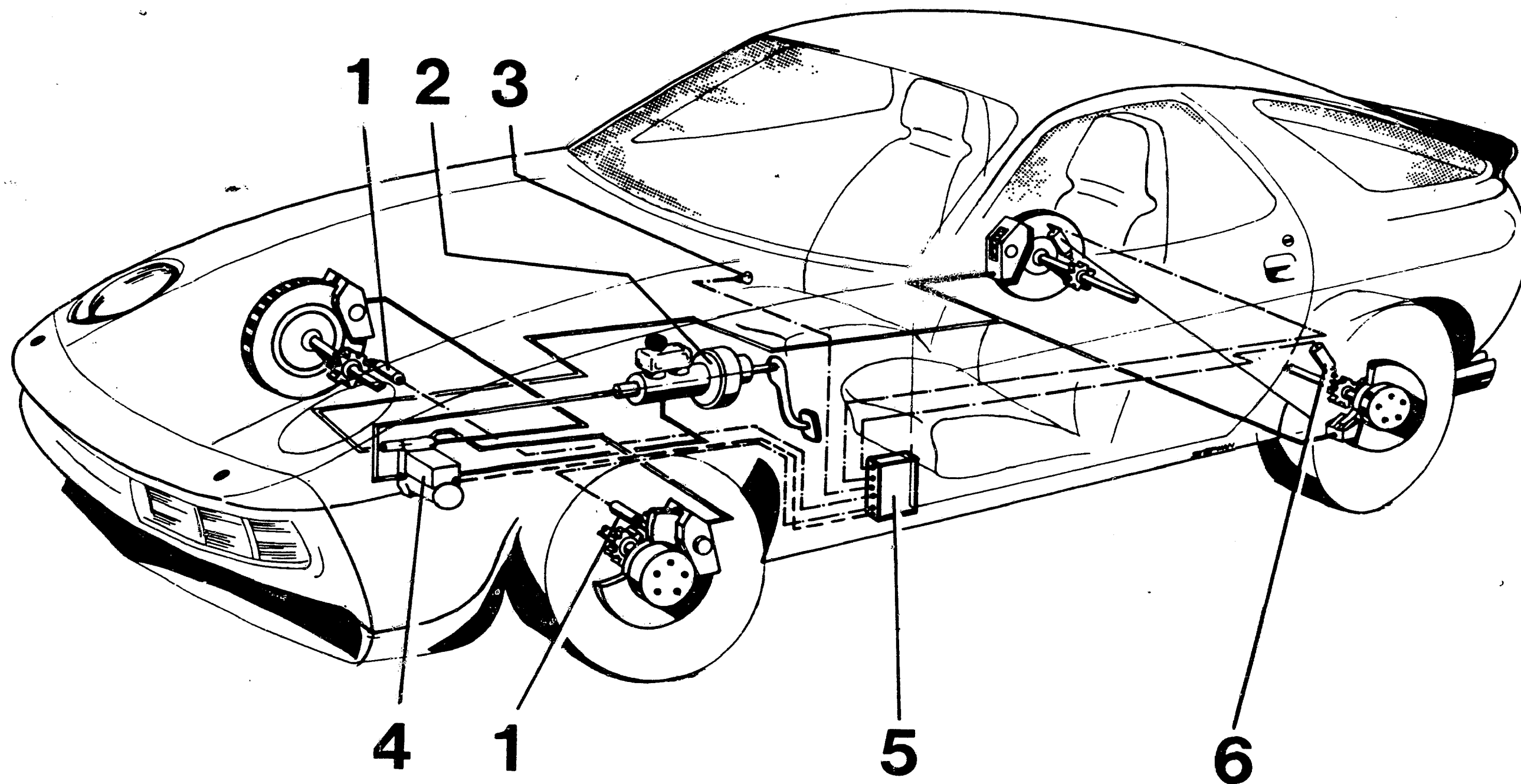


ELECTRICAL TERMINAL DIAGRAM

A1 = Tire-inflation-pressure monitoring system (if provided)
 B1 = Wheel-speed sensor
 G1 = to alternator
 H1 = ABS warning lamp
 K1 = Valve relay
 K2 = Motor relay

K3 = Over-voltage protection relay
 M1 = Return pump motor
 S1 = Stop-lamp switch
 X1 = Controller plug (35-pole)
 X2...X5 = Wheel-speed-sensor plugs
 Y1 = Hydraulic modulator
 Y2 = Solenoid valves

h = Rear axle
 HL = Rear left
 HR = Rear right
 VL = l = front left
 VR = r = front right
 *) = Hydraulic modulator designed for ETC (lock control)

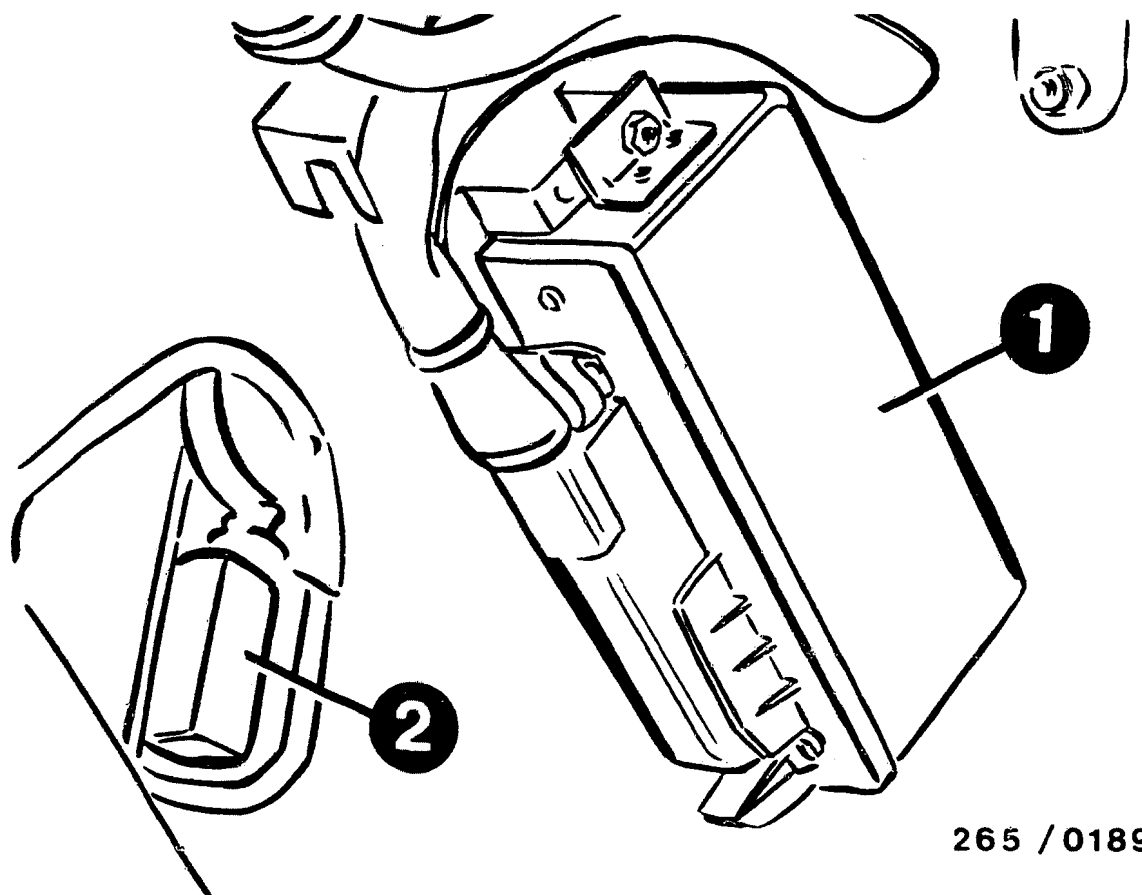


2650188

INSTALLATION POSITION OF COMPONENTS

1 = Wheel-speed sensor, front
 2 = Brake assembly
 3 = ABS warning lamp

4 = Hydraulic modulator
 5 = ABS controller
 6 = Wheel-speed sensor, rear



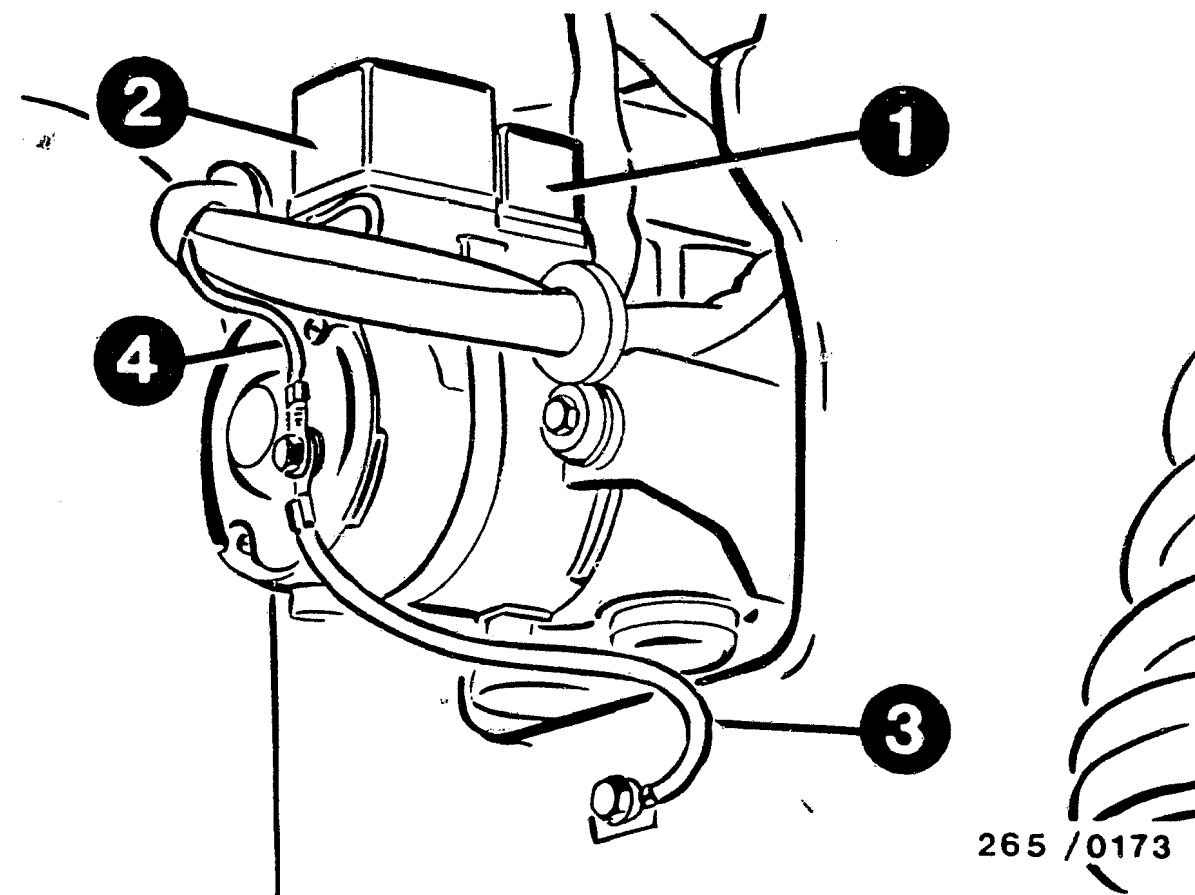
265 / 0189

- 1 = ABS controller
- 2 = Hood release mechanism

INSTALLATION POSITION OF COMPONENTS (continued)

The installation locations always refer to the direction of travel.

- * Controller:
In driver's footwell on the left above hood release mechanism.
- * Over-voltage protection relay:
In central-electrics console, relay no. 11
- * ABS warning lamp:
In instrument cluster. Symbol: ABS.
- * Stop-lamp switch:
At brake pedal lever.



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- 1 = Valve relay
- 2 = Motor relay
- 3 = Ground connection, return pump
- 4 = Ground connection, valve relay (if provided).

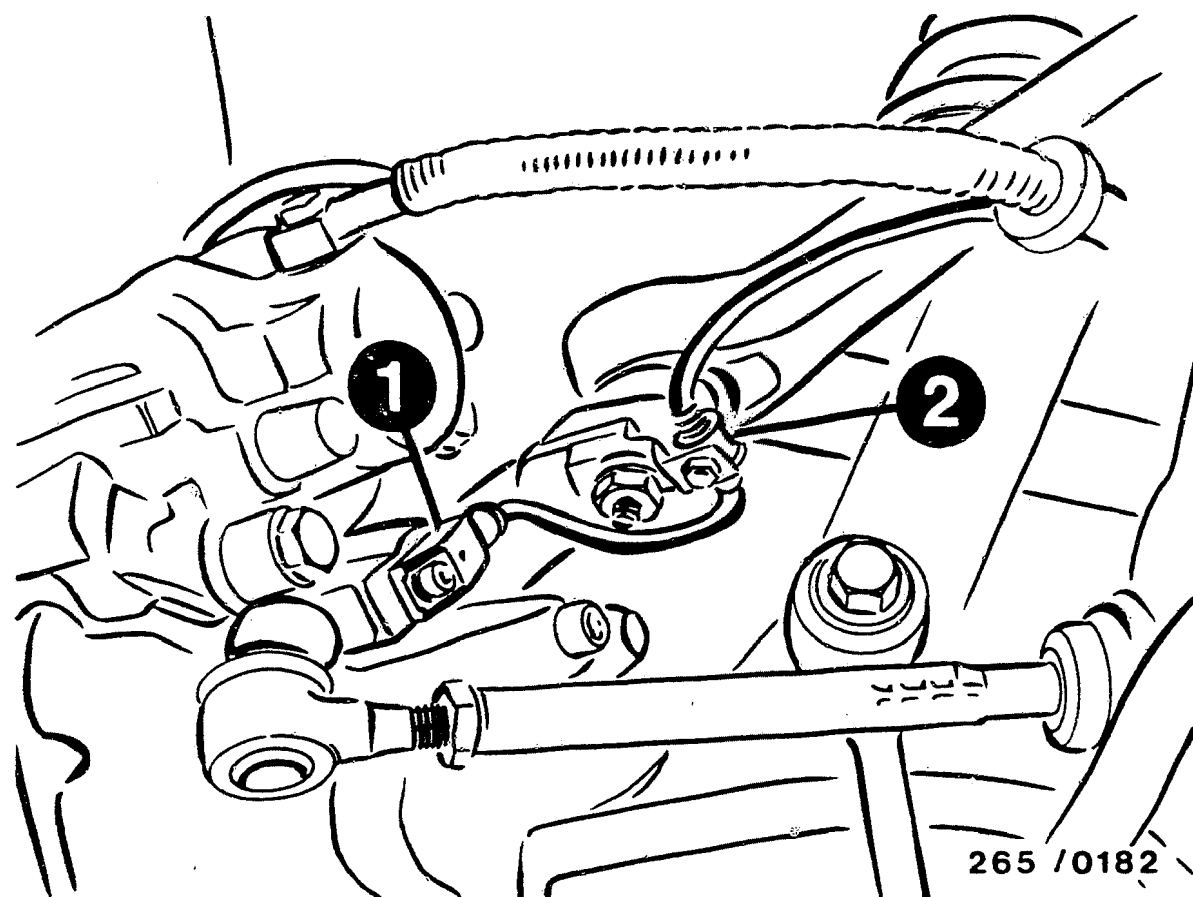
INSTALLATION POSITION OF COMPONENTS (continued)

- * Hydraulic modulator:
In engine compartment front left in penetration through wheel wall.
To remove, unscrew left-hand wheel and remove cover in wheel wall.

The hydraulic modulator is not to be repaired, but rather only replaced as a complete unit.
Exception: Relay change.

Pay attention to correct assignment of brake-line connections.

- * ABS ground terminal:
Beneath steering console, in vicinity of stop-lamp switch.



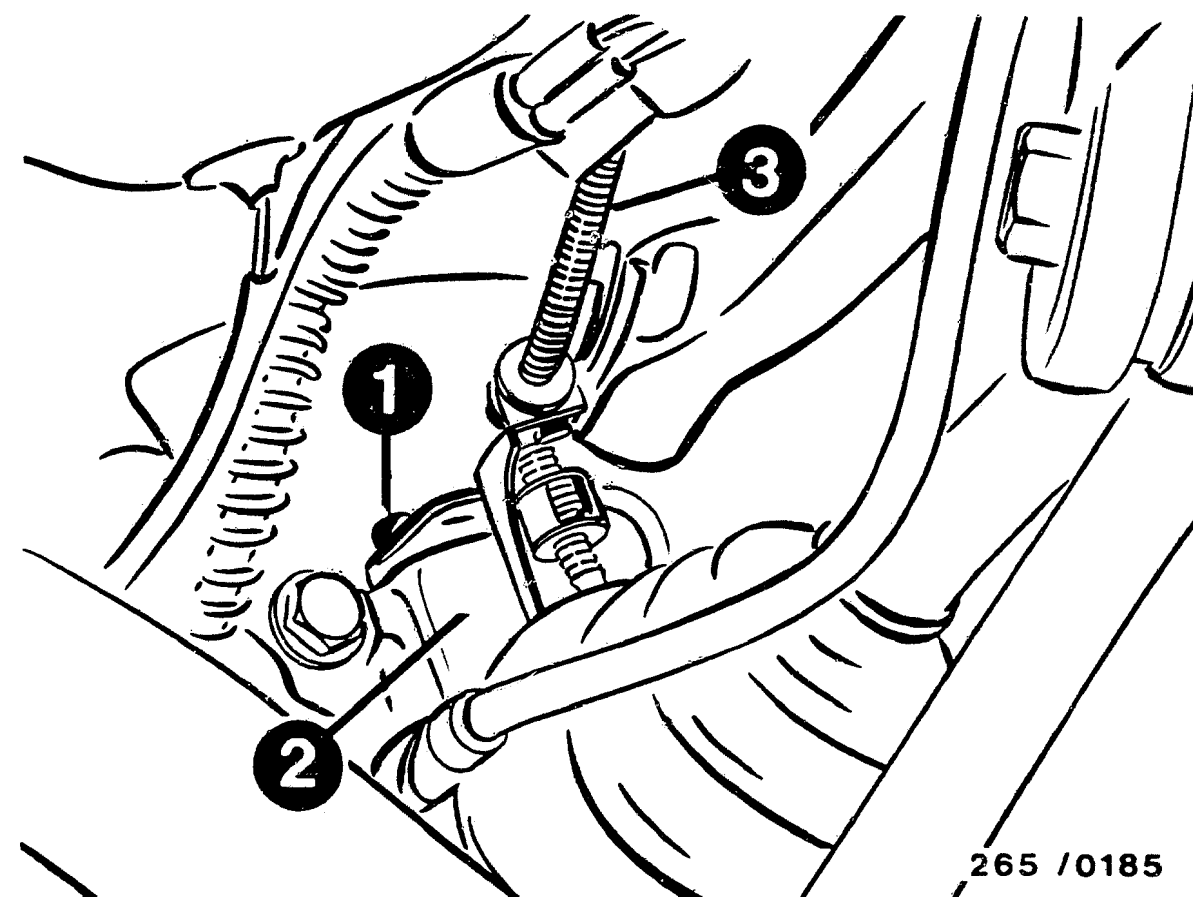
- 1 = Wheel-speed sensor
- 2 = Cable clamp

INSTALLATION POSITION OF COMPONENTS (continued)

- * Front-axle wheel-speed sensor:
One each on left and right in steering knuckles.

Wheel-speed-sensor plug connections:

In engine compartment on left and right at spring strut dome.



- 1 = Wheel-speed sensor, rear
- 2 = Wheel carrier
- 3 = Wheel-speed-sensor lead

INSTALLATION POSITION OF COMPONENTS (continued)

- * Rear-axle wheel-speed sensor:
One each on left and right in wheel carrier.

Wheel-speed-sensor plug connections:

On left and right at rear-axle cross-member.

Trouble-shooting instructions : REN-5003
BOSCH system : ABS
Make of vehicle : RENAULT
Basic microcard : KFZ-00..

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SPECIAL FEATURES

This microcard, valid at the time of publication, contains trouble-shooting instructions for the following models:

Renault Alpine 12.86 ->

- * ABS with 4 wheel-speed sensors and 3 hydraulic channels.
- * Number of teeth on sensor ring gears:
41 teeth at front wheels,
44 teeth at rear wheels.
- * Lateral acceleration sensor (a q)

STRUCTURE, USAGE

These brief instructions encompass essentially vehicle-specific special features and test specifications (set values).

For a detailed description of trouble-shooting, see the basic instructions.

ATTENTION :
The set values, terminal assignments and special features of these vehicle-specific brief instructions are always binding.

SAFETY AND PRECAUTIONARY MEASURES

- * For safety reasons, the hydraulic modulator must not be repaired, but be exchanged as a complete unit.
Exception: relays.
- * Do not loosen any screws on the hydraulic modulator!
Danger of fatal accident due to brake failure.
- * Caution when handling brake fluid.
Poisonous!

For further information, see basic instructions.

TEST REQUIREMENTS FOR TESTING WITH ABS2 LED TESTER

- * Regulatory tire size fitted?
- * Check for firm seating of ground of return-supply pump.
- * Check for firm seating and corrosion of ground of overvoltage-protection relay term. 31.
- * Check for firm seating of ground strap between engine block and vehicle frame.
- * Check for leaks in hydraulic connections at hydraulic modulator and sealing points (visual examination).
- * If the ABS warning lamp lights up intermittently when driving (e.g. after switching on loads) and goes out again by itself, check the battery and power supply (alternator, regulator and voltage drops).
- * If the ABS warning lamp lights up constantly and does not go out, check the following points:
 - Controller plug sitting correctly on controller and latched?
 - All plug contacts O.K.?
 - Spring contacts latched?
 - Check installation position for correct seating of seal ring in controller plug, rounded side downward.

- Check wheel-speed-sensor leads for correct assignment at controller plug:

Wheel-speed sensors:

front left to term. 6 and term. 4.
front right to term. 11 and term. 21.
rear left to term. 8 and term. 9.
rear right to term. 24 and term. 26.
rear axle to term. — and term. —.

- V-belt snapped?
(Alternator provides no voltage, charge-indicator lamp and ABS warning lamp light up).
- * Connect ABS 2 LED tester to ABS wiring harness.
- Disconnect and connect controller only with ignition switched off.
- For testing, switch on ignition in all program-selector-switch positions (tester operates with current supply from vehicle battery).
- Observe LED (green) for current supply in all program-selector-switch positions.

C A U T I O N !

Do not drive with tester connected!

The brake system must be bled of air before the ABS test. Do not activate the ABS tester while the system is being bled.

Repeat the complete test program after any repairs are carried out.

The Antiskid System is a vehicle safety system.

Work on the system demands detailed knowledge of the system.

The conventional brake system must be O.K.

General information for trouble-shooting:

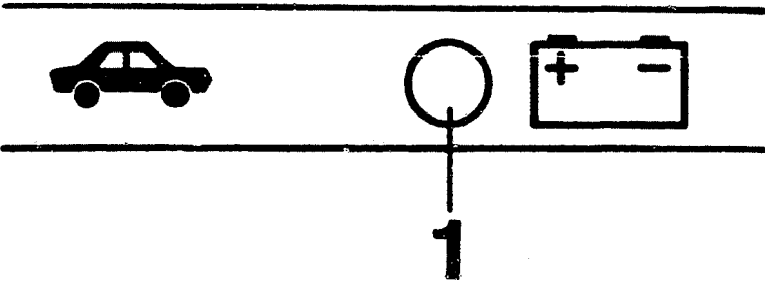
Check all leads for short circuit to ground and contact with positive leads and watch out for worn cable insulation and pinched leads.

RAPID DIAGNOSIS CHART

Do not drive with tester connected. Are all test conditions met?

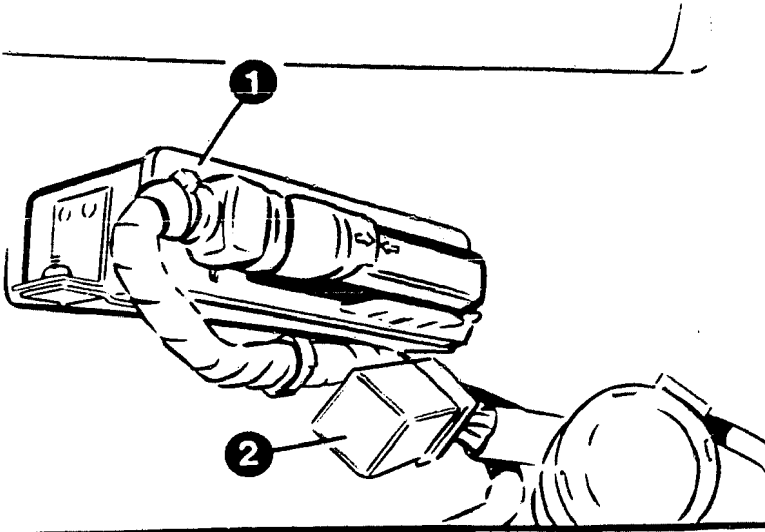
Program-switch positions 1 to 6

Testing of (measurement at terminals)	Additional operation	Test specifi- cation (reading)	Possible causes of faults
Power supply (term.1 und term.20)	Ignition on	LED 1 (top picture) continuously lit	<ul style="list-style-type: none">*Battery insufficiently charged*High voltage drops*Overvoltage-protection relay defective*Check lead to ignition and starting switch, term. 15



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- 1 = ABS controller
- 2 = Over-voltage protection relay

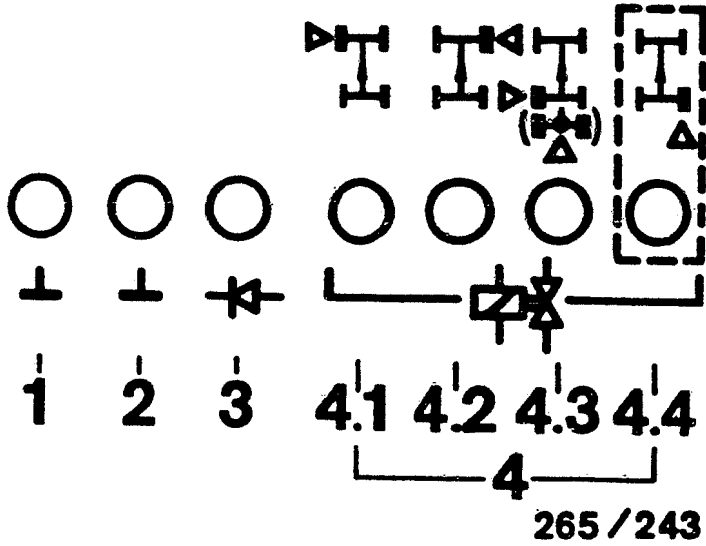


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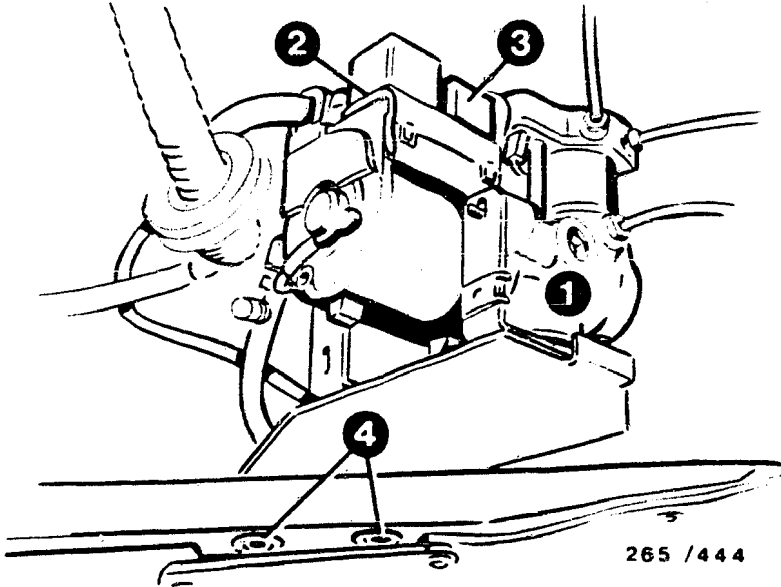
RAPID DIAGNOSIS CHART (CONTINUED)

Program-switch position 1 (3-channel hydraulic modulator)

Testing of (measurement at terminals)	Addition- al operation	Test specifi- cation (reading)	Possible causes of faults
Ground connection (term.10, term.34) Diode for warning lamp (term.29, term.32) Solenoid-operated valve internal res. (term.2, term.18, term.-, term.35) Off-position and ground connection of relay ABS warning lamp	Ignition on	6 LED (1 to 4.3) simultaneously brightly lit (top picture) ABS warning lamp in vehicle must light up	<ul style="list-style-type: none">* LED 1 and/or 2 (top picture) not lit: Check ground terminals for open circuit.* LED 3 (top picture) not lit: Diode defective, check ground connection of valve relay.* One or more LEDs 4 not lit: Check corresponding plug-in connection for solenoid- operated valve and leads.Solenoid-operated valve internal resistance 0,7...1,7 Ω* All LEDs 4 and LEDs 3 not lit: Check ground connection of valve relay, valve relay defective.* Dimmer lighting-up of an LED means contact resistance in the corresponding circuit.* ABS warning lamp not lit: Warning lamp defective. Note: all other 5 LEDs lit.



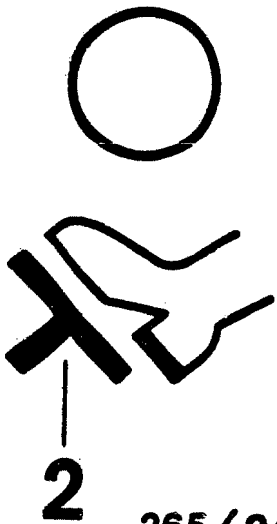
- 1 = Hydraulic modulator
- 2 = Motor relay
- 3 = Valve relay
- 4 = Screws for
fastening plate



RAPID DIAGNOSIS CHART (CONTINUED)

Program-selector-switch setting 2

Testing of (measurement at terminals)	Additional operation	Test specification (indication)	Possible causes of fault (see coordinate)
Oil-pressure- switch voltage (term.15)	Ignition on	LED 1 (top picture) lights up.	* LED sometimes does not go out until accelerator has been depressed (test is thus O.K.)
	Start engine	LED 1 (top picture) goes out when engine is running	* Check lead to oil-pressure switch. * Oil-pressure switch defective.
Brake-light switch (term. 25)	Ignition on	LED 2 (top picture) lights up	* Brake-light switch defective. * Check lead to brake-light switch.
	Press brake pedal	LED 2 (top picture) goes out	* Lead incorrectly connected at brake-light switch. * 6pole plug connection defective.

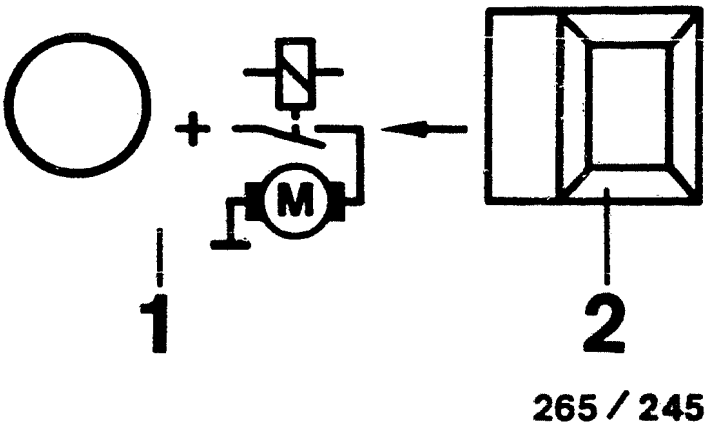


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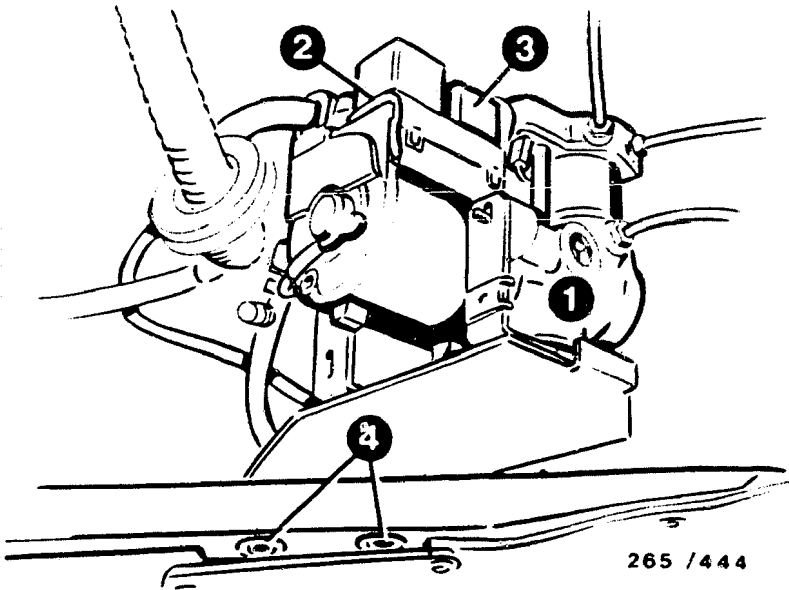
RAPID DIAGNOSIS CHART (CONTINUED)

Program-selector-switch setting 3

Testing of (measurement at terminals)	Additional operation	Test specifications (indication)	Possible causes of fault
Motor relay, pump motor in hydraulic modulator (term. 14 and term.28)	Ignition on, press button 2 contin- uously (top picture)	LED 1 lights up, pump motor running. After releasing button, LED continues to light up as a result of motor run-on (top picture).	<ul style="list-style-type: none">* Motor relay defective* Check ground connection and positive terminal of pump motor* Check following leads: from controller, term. 14 and term. 28 to hydraulic modulator, term. 9 or term. 11. Positive lead to hydraulic modulator, term. 10.* Pump motor or hydraulic modulator defective.



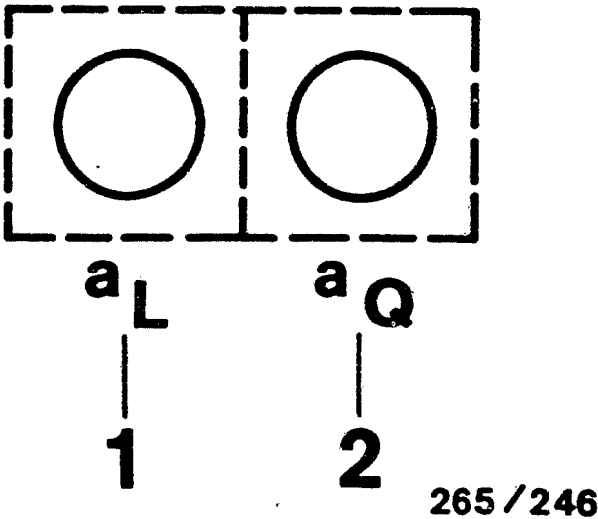
- 1 = Hydraulic modulator
- 2 = Motor relay
- 3 = Valve relay
- 4 = Screws for
fastening plate



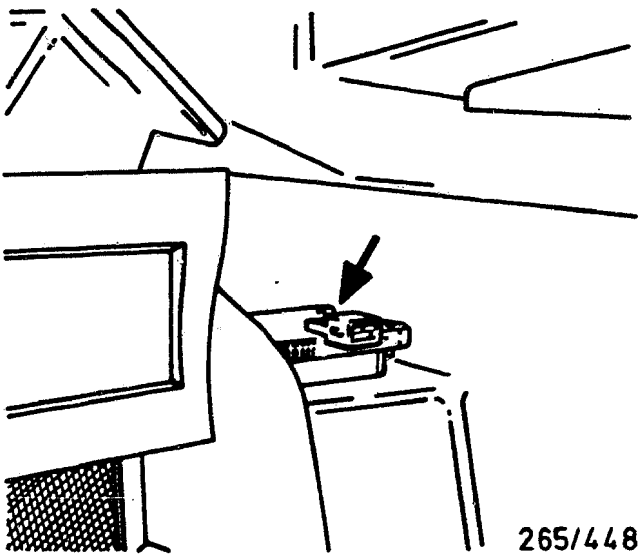
RAPID DIAGNOSIS CHART (CONTINUED)

Program-selector-switch setting 4

Testing of (measurement at terminals)	Addition- al operation	Test specification (indication)	Possible causes of fault
Lateral accelera- tion sensor a Q (term. 13)	Ignition on	LED a Q lights up	<ul style="list-style-type: none">* Check lateral acceleration sensor: Resistance: < 100 ΩWhen fitting sensor, do not forget spacer sleeves and pay attention to correct installation position.* Check lead from lateral accelera- tion sensor to ABS controller, term. 13.* Check lead from controller, term. 1 to lateral accelera- tion sensor.

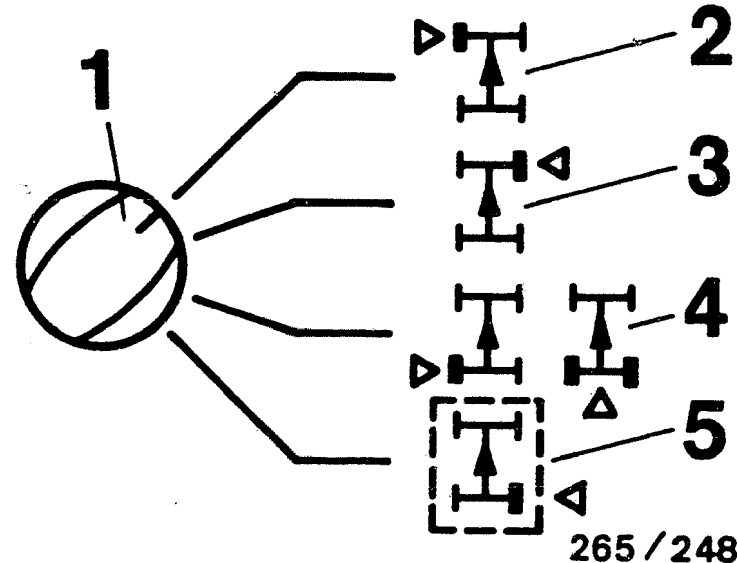
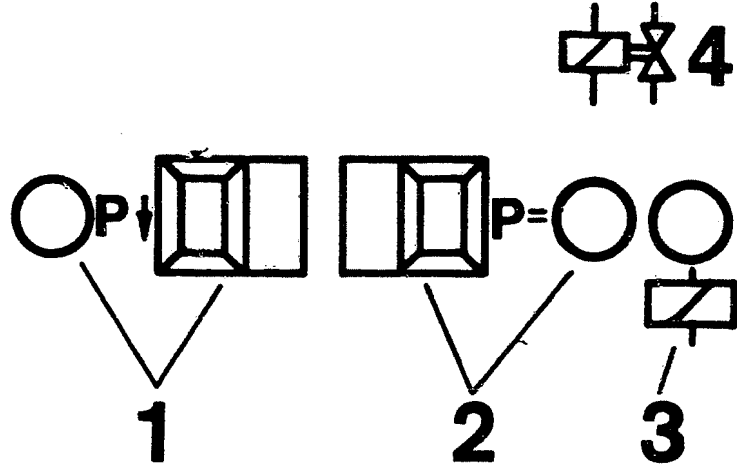


Arrow = Lateral acceleration sensor



RAPID DIAGNOSIS CHART (CONTINUED)
Program-selector-switch position 5 (3-channel hydraulic modulator)

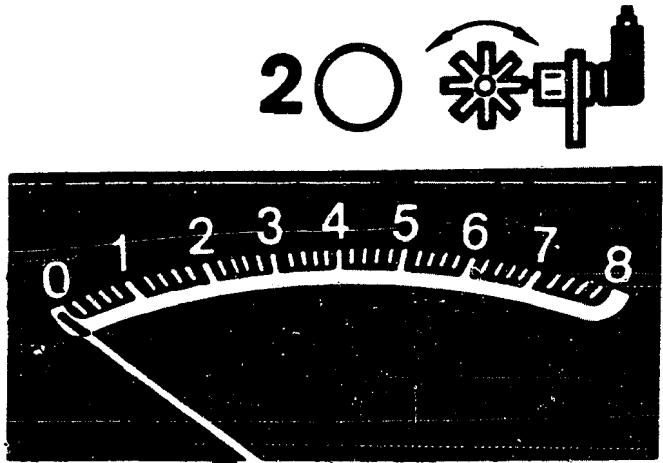
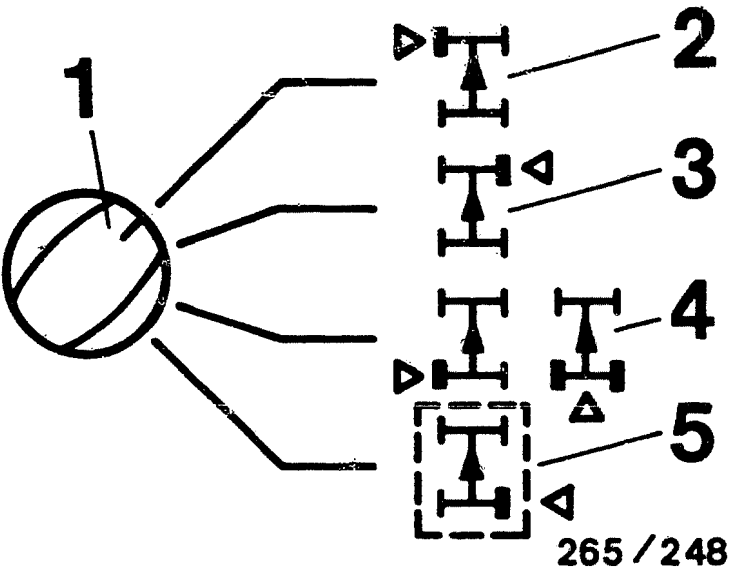
Test (measurement at terminals)	Additional operator action	Test specification (indication)	Possible fault causes
Valve-relay operation (term. 27)	Ignition on	LED 3 (upper illustration) lights up	* Valve relay (winding) or leads defective
Operation of solenoid valves in hydraulic modulator and connection correct way round. NOTE: Perform test consecutively for each wheel individually. Keep to operational sequence.	Jack up vehicle. Switch on ignition. You must be able to turn wheel under test freely by hand. Set switch 1 for wheel selection to the wheel under test. For rear axle, set to pos.4 (center illus.).		* Repeat test with engine running * Valve relay (working contact) defective * Open circuit in lead from valve relay term. 87 to B+ * Brake lines on hydraulic modulator mixed up
Pressure-holding function	1. Hold button P= (upper illus.) constantly pressed	LED P= (upper illus.) lights up	* Current value not reached (LED P arrow or P= go out; upper illustration): Battery inadequately charged. Repeat test with engine running.
	2. Hold brake pedal down constantly	Wheel can be turned by hand	
	3. Release button P= (upper illus.)	LED P= goes out (upper illus.) Wheel blocked	
Pressure-reduction function	4. Press button P arrow (upper illus.)	LED P arrow (upper illus.) lights up, wheel can be turned by hand	* Electrical connections of solenoid valves correct? Wheel front left: term. 2 Wheel front right: term.35 Wheel rear left: term.— Wheel rear right: term.— Rear axle: term.18 * Hydraulic modulator defective
	5. Release button P arrow (upper illus.)	LED P arrow (upper illus.) goes out, wheel blocked	
	6. Release brake pedal		



RAPID DIAGNOSIS CHART (CONTINUED)

Program-selector-switch position 6 (4 wheel-speed sensors)

Under test (measurement at the terminals)	Additional operation	Test specification (reading)	Possible causes of trouble
<p>Wheel-speed sensor for operation and mix-up</p> <p>NOTE: Check each wheel separately in turn.</p> <p>Wheel, front left: term.4 and t.6</p> <p>Wheel, front right: term.11 and term.21</p> <p>Wheel, rear left: term.8 and term.9</p> <p>Wheel, rear right: term.24 and term.26</p>	<p>Chock-up vehicle. Ignition on.</p> <p>The wheel being tested must be freely turn- able by hand.</p> <p>When testing the driven axle, the wheel not being tested must be locked.</p> <p>Set switch for wheel selection to wheel to be tested (lower illustration)</p> <p>Turn wheel by hand until LED 2 above instrument lights up without flickering. (Wheel speed approx. 1 revolution per second). Afterwards, read off indication at instrument: (upper illustration)</p>	<p>1. Smallest reading larger 1,6 divisions</p> <p>2. Permissible fluctuation max. 25 % of largest reading.</p>	<p>*Wheel-speed-sensor lead mixed up</p> <p>*Brake in wheel-speed- sensor lead</p> <p>*Wheel-speed sensor defective</p> <p>Winding resistance Front axle: 0,6...1,6 k Ω</p> <p>Rear axle: 0,6...1,6 k Ω</p> <p>*Air gap between wheel- speed sensor and ring gear too wide</p> <p>*Ring gear defective (e.g. corroded, dirty) or loose.</p> <p>*Ring gear with incorrect number of teeth installed Front axle: 41 teeth Rear axle: 44 teeth</p> <p>*Wheel-bearing clearance too large</p> <p>*Instrument gives reading, LED 2 does not light up: loose contact in wheel- speed sensor lead.</p>



1

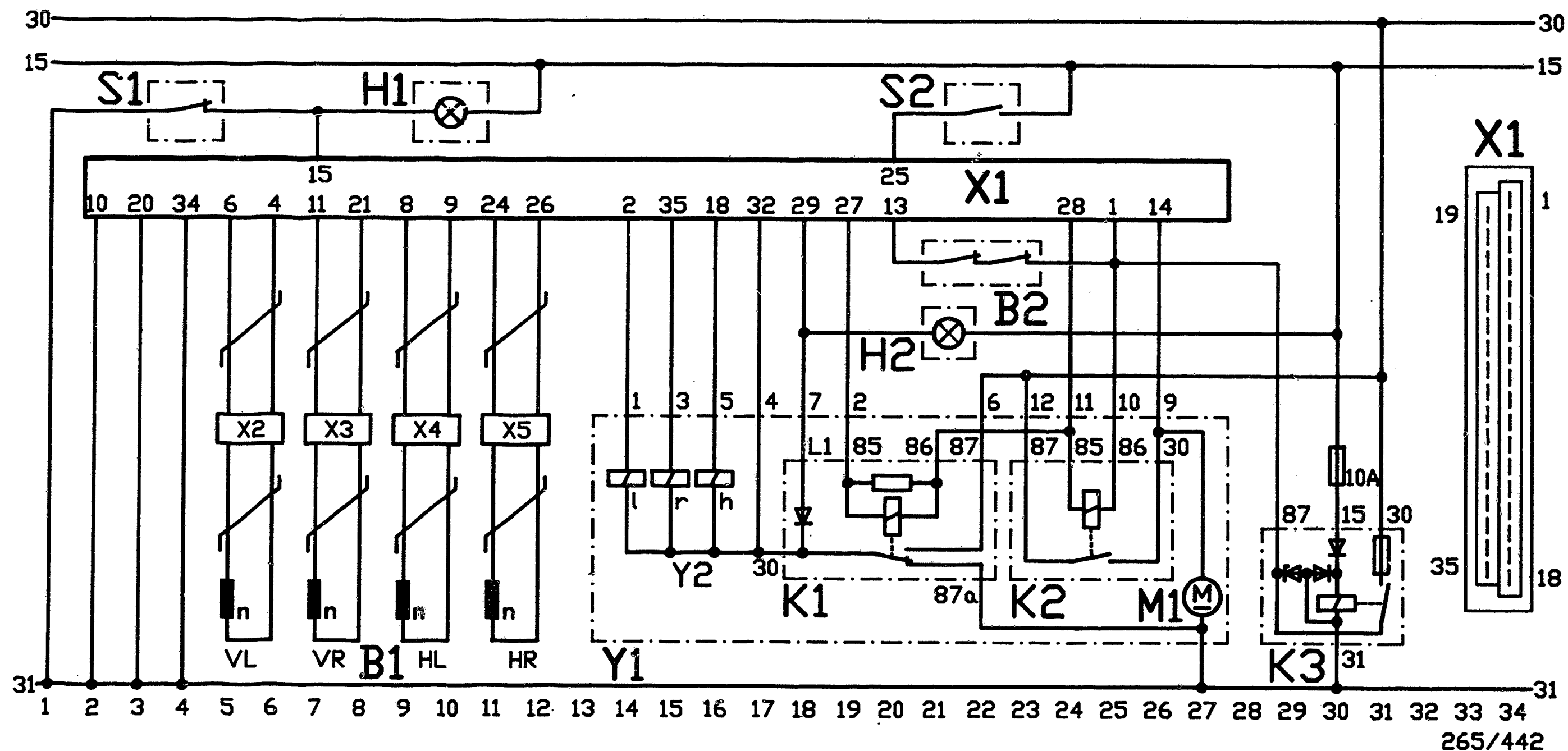
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TEST SPECIFICATIONS

Wheel-speed sensor		
* Winding resistance at ambient temperature (-10°C...+120°C) for front wheels:	600...1600	Ω
rear wheels:	600...1600	Ω
Hydraulic-modulator solenoid valves		
* Winding resistance at ambient temperature (-10°C...+120°C):	0,7... 1,7	Ω
Air gap between wheel-speed sensor and ring gear		
* at front wheels:	0,1...0,87	mm
* at rear wheels:	0,1...0,95	mm
Tightening torque for		
* fastening screws of wheel-speed sensors:	> 8	Nm
* Brake-line connections at hydraulic modulator:	12... 16	Nm
* Fastening screws for wheel-speed-sensor mount		
at front wheels:	8	Nm
at rear wheels:	40	Nm
Number of teeth on wheel-speed-sensor ring gears		
* at front wheels:	41	teeth
* at rear wheels:	44	teeth
Lateral acceleration sensor		
* Contacts closed in horizontal position:	< 100	Ω

For production reasons:
continued on the following
coordinate.



B1 = Wheel-speed sensor
 B2 = Lateral acceleration sensor
 H1 = Oil-pressure warning lamp
 H2 = ABS warning lamp
 K1 = Valve relay
 K2 = Motor relay

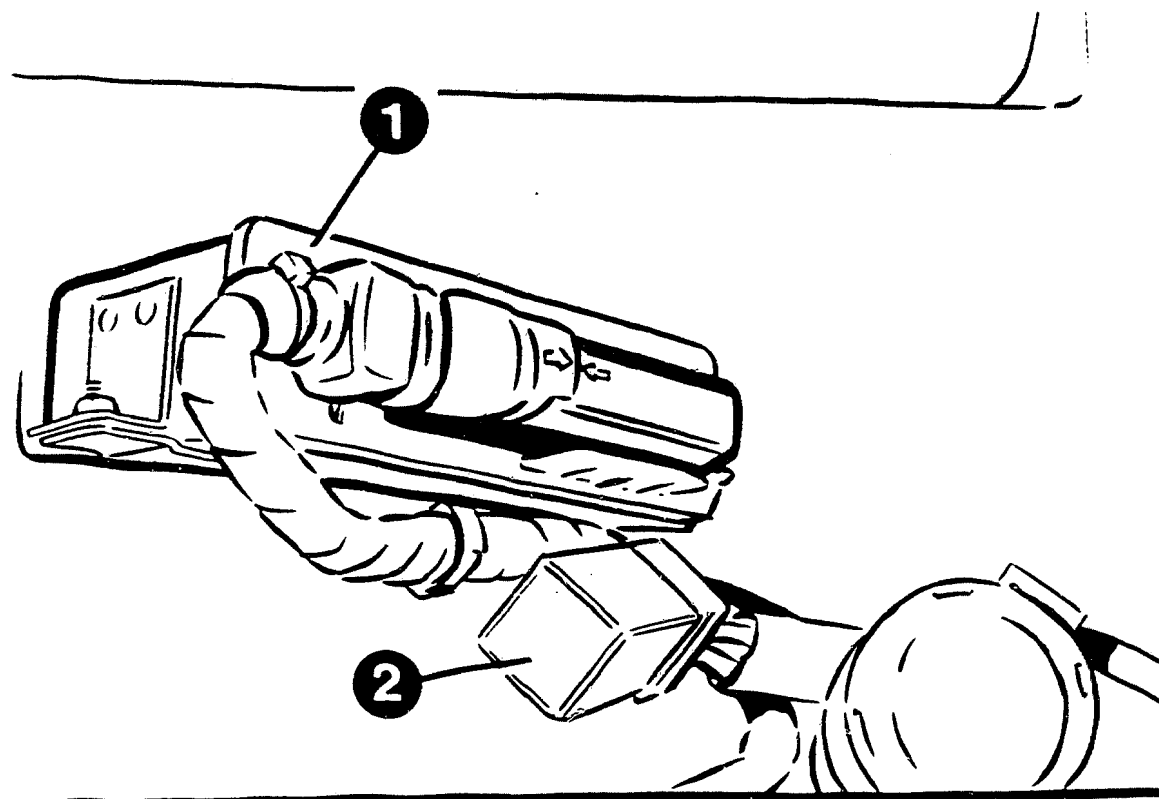
K3 = Over-voltage protection
 relay
 M1 = Return-pump motor
 S1 = Oil-pressure switch
 S2 = Brake-light switch
 X1 = Controller plug (35 pole)
 X2...X5 = Wheel-speed-sensor plug

Y1 = Hydraulic modulator
 Y2 = Solenoid valves
 HL = Rear left
 HR = Rear right
 h = Rear axle
 VL = l = Front left
 VR = r = Front right

ELECTRICAL TERMINAL DIAGRAM 12.86 ->

D21 ———— ==>

D22 ———— <==



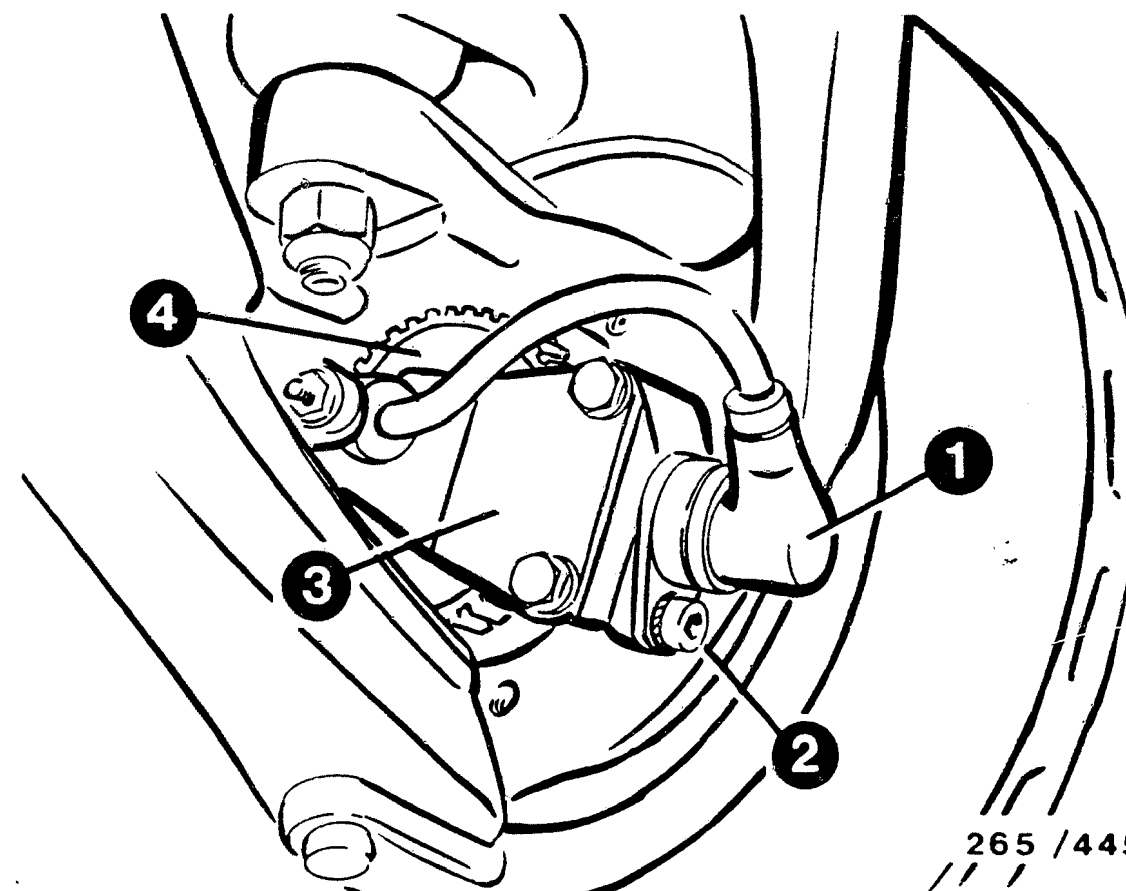
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- 1 = ABS controller
- 2 = Over-voltage protection relay

INSTALLATION POSITION OF COMPONENTS

The information given on installation locations always refers to the direction of travel.

- * ABS controller:
Up to approx. mid 88: in trunk, on right-hand side next to battery beneath a cover.
As of approx. mid 88: in trunk, on right-hand side beneath trunk lining. Remove complete lining.
- * Over-voltage protection relay:
In trunk, on left-hand side next to battery or in trunk, on right-hand side beneath trunk cover.
- * ABS warning lamp:
In instrument panel. Symbol: swerving vehicle.

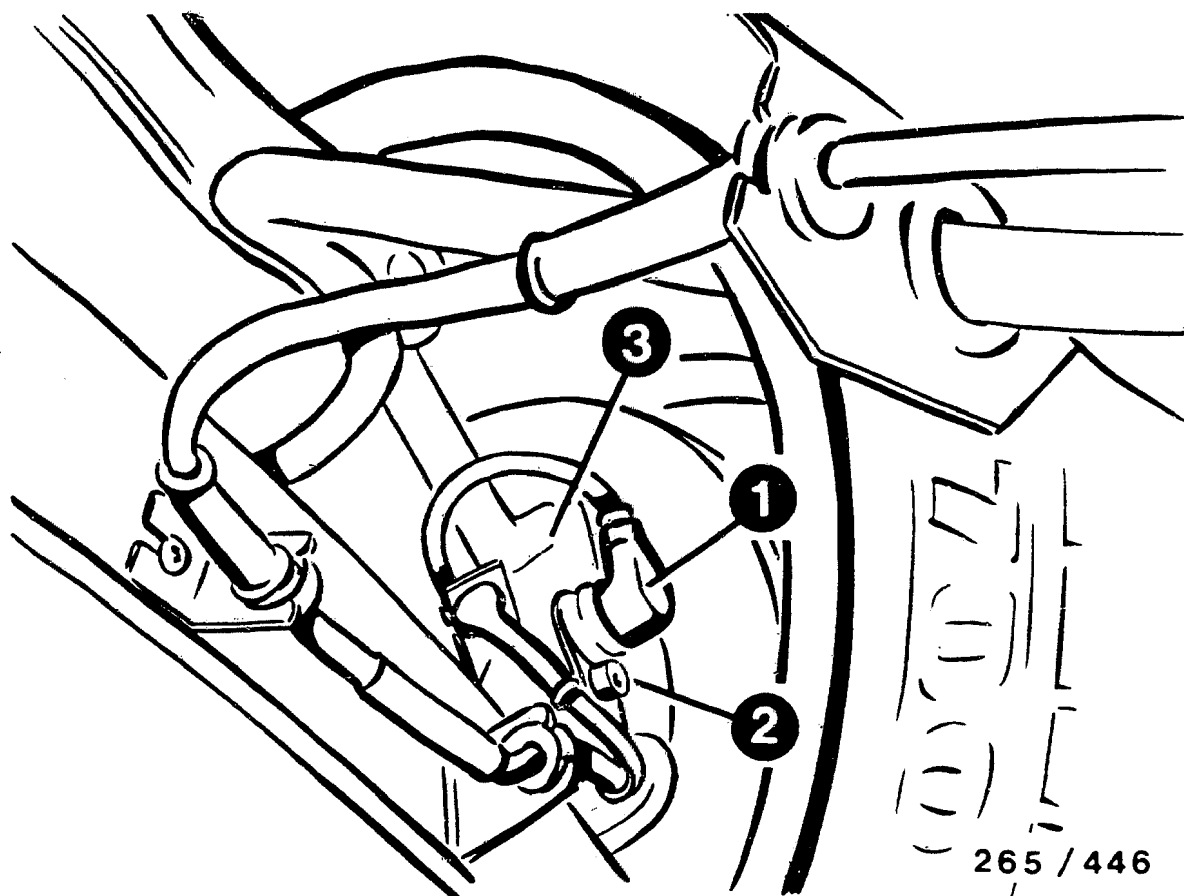


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- 1 = Wheel-speed sensor, front
Do not unscrew mount (3) when removing!
- 2 = Fastening screw
- 4 = Ring gear

INSTALLATION POSITION OF COMPONENTS (continued)

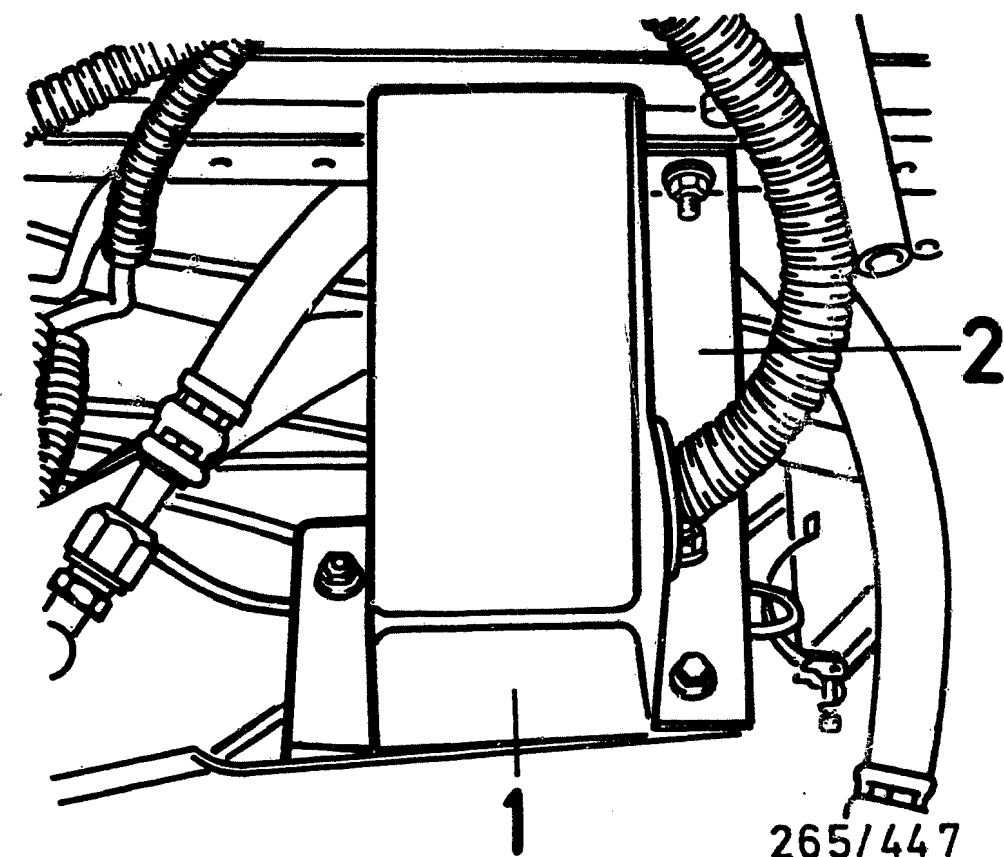
- * Wheel-speed sensor, front axle:
One each on left and right at steering-knuckle supports.
Plug connections in front wheel houses.
- * ABS ground terminal:
In front of battery, at bottom.



- 1 = Wheel-speed sensor, rear
Do not unscrew mount (3) when removing!
2 = Fastening screw

INSTALLATION POSITION OF COMPONENTS (continued)

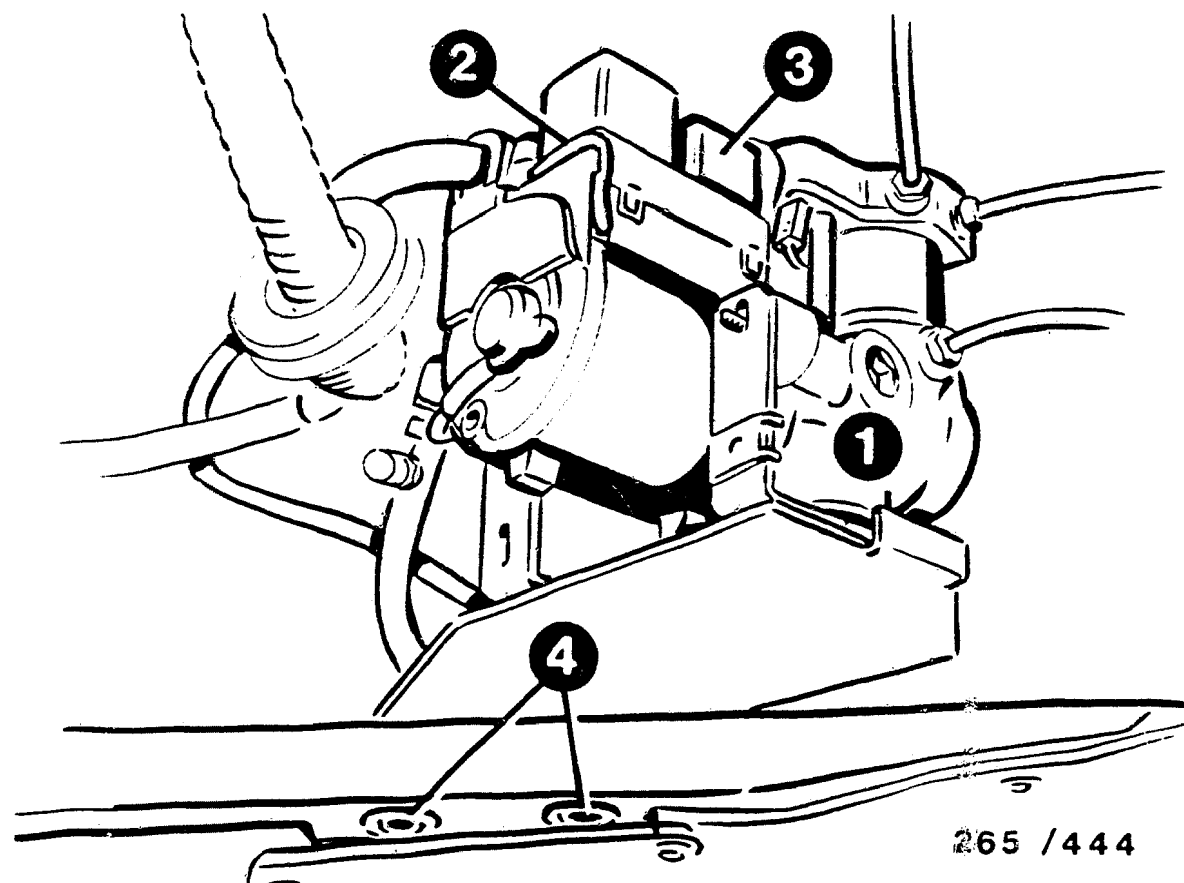
- * Wheel-speed sensor, rear axle:
One each on left and right opposite brake caliper.
Plug connections underneath vehicle on left and right at cross member.
- * Braking-force regulator:
Beneath vehicle, at rear; to the left of the transmission.



- 1 = Cover
2 = Retaining bracket

INSTALLATION POSITION OF COMPONENTS (continued)

- * Hydraulic modulator:
In wheel house, front right, behind a cover.
The hydraulic modulator cannot be repaired, but rather it is to be replaced as a complete unit.
Exception: relay change.

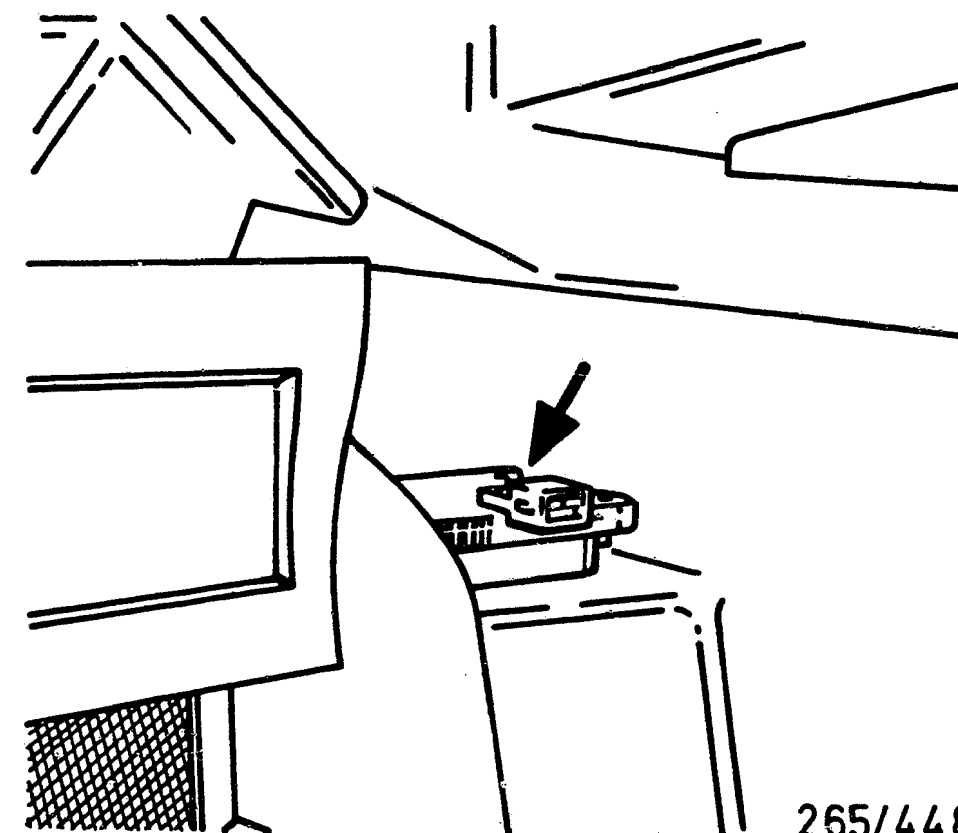


- 1 = Hydraulic modulator
 2 = Motor relay
 3 = Valve relay
 4 = Screws for fastening plate

INSTALLATION POSITION OF COMPONENTS (continued)

Removal instructions for changing relay:
 Remove protective cover above hydraulic modulator including retaining bracket.
 Loosen fastening plate to enable hydraulic modulator to be lowered somewhat.
 Loosen Torx screw in hydraulic-modulator cover.
 Pull out cover first upwards and then forwards.

Before removing hydraulic modulator, mark brake-line connections in line with marking on hydraulic modulator. Ensure correct connection of brake lines when installing.



Arrow = Lateral acceleration sensor

INSTALLATION POSITION OF COMPONENTS (continued)

* Lateral acceleration sensor:
 Beneath instrument panel in transmission tunnel.
 Remove right-hand tunnel cover.
 When fitting, observe direction of installation and do not forget spacer sleeves.

Trouble-shooting instructions : REN-5004
BOSCH system : ABS
Make of vehicle : RENAULT
Basic microcard : KFZ-00..

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SPECIAL FEATURES

This microcard contains trouble-shooting instructions, valid at the time of publication, for the following models:

RENAULT Espace 10.88 ->
RENAULT Espace Quadra (4-WD) 10.88 ->

- * ABS with 4 wheel-speed sensors and 4 hydraulic channels.
- * Number of teeth on sensor ring gears: 48
- * Longitudinal acceleration switch (a L) for 4-WD vehicles.

STRUCTURE, USAGE

These brief instructions encompass essentially vehicle-specific special features and test specifications (set values).

For a detailed description of trouble-shooting, see the basic instructions.

ATTENTION :
The set values, terminal assignments and special features of these vehicle-specific brief instructions are always binding.

TEST REQUIREMENTS FOR TESTING WITH ABS2 LED TESTER

- * Regulatory tire size fitted?
- * Check for firm seating of ground of return-supply pump.
- * Check for firm seating and corrosion of ground of overvoltage-protection relay term. 31.
- * Check for firm seating of ground strap between engine block and vehicle frame.
- * Check for leaks in hydraulic connections at hydraulic modulator and sealing points (visual examination).
- * If the ABS warning lamp lights up intermittently when driving (e.g. after switching on loads) and goes out again by itself, check the battery and power supply (alternator, regulator and voltage drops).
- * If the ABS warning lamp lights up constantly and does not go out, check the following points:
 - Controller plug sitting correctly on controller and latched?
 - All plug contacts O.K.?
 - Spring contacts latched?
 - Check installation position for correct seating of seal ring in controller plug, rounded side downward.

- Check wheel-speed-sensor leads for correct assignment at controller plug:

Wheel-speed sensors:

front left to term. 5 (22) and term. 4.
front right to term. 11 and term. 21.
rear left to term. 7 and term. 9.
rear right to term. 24 and term. 26.
rear axle to term. — and term. —.

- V-belt snapped?
(Alternator provides no voltage, charge-indicator lamp and ABS warning lamp light up).
- * Connect ABS 2 LED tester to ABS wiring harness.
- Disconnect and connect controller only with ignition switched off.
- For testing, switch on ignition in all program-selector-switch positions (tester operates with current supply from vehicle battery).
- Observe LED (green) for current supply in all program-selector-switch positions.

C A U T I O N !

Do not drive with tester connected!

The brake system must be bled of air before the ABS test. Do not activate the ABS tester while the system is being bled.

Repeat the complete test program after any repairs are carried out.

The Antiskid System is a vehicle safety system.

Work on the system demands detailed knowledge of the system.

The conventional brake system must be O.K.

General information for trouble-shooting:

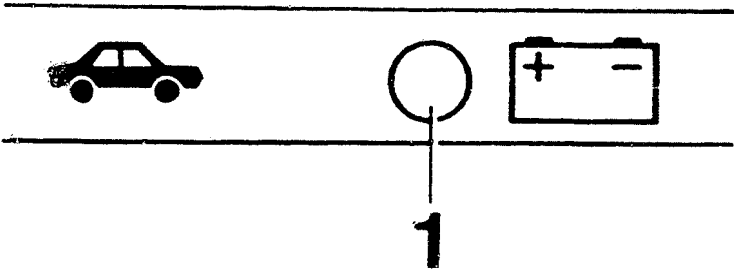
Check all leads for short circuit to ground and contact with positive leads and watch out for worn cable insulation and pinched leads.

RAPID DIAGNOSIS CHART

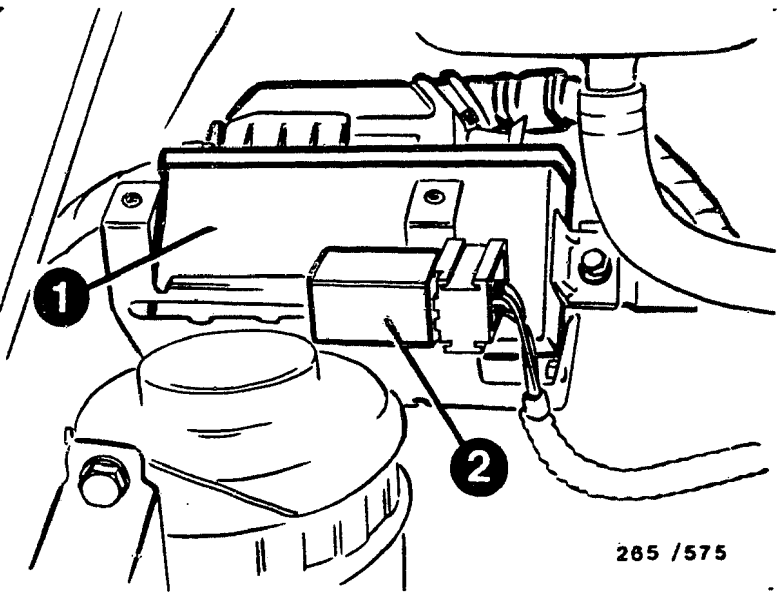
Never drive with tester connected! Have all test prerequisites been met?

Program-selector-switch positions 1 - 6

Testing of (measurement at terminals)	Additional operation	Test specification (indication)	Possible causes of trouble
Voltage supply (Term.1 and term.20)	Ignition on	LED 1 (Top picture) lights up constantly	<ul style="list-style-type: none">* Battery not sufficiently charged* Excessive voltage dips. * Check leads from relay plug to controller term.1, to driving switch term.15, to battery B+ and to ground terminal. Check ground lead to controller term.20. * Over-voltage protection relay defective.



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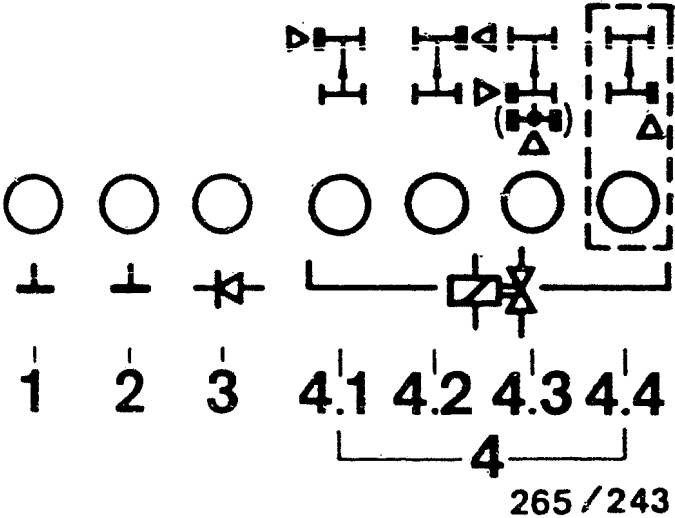


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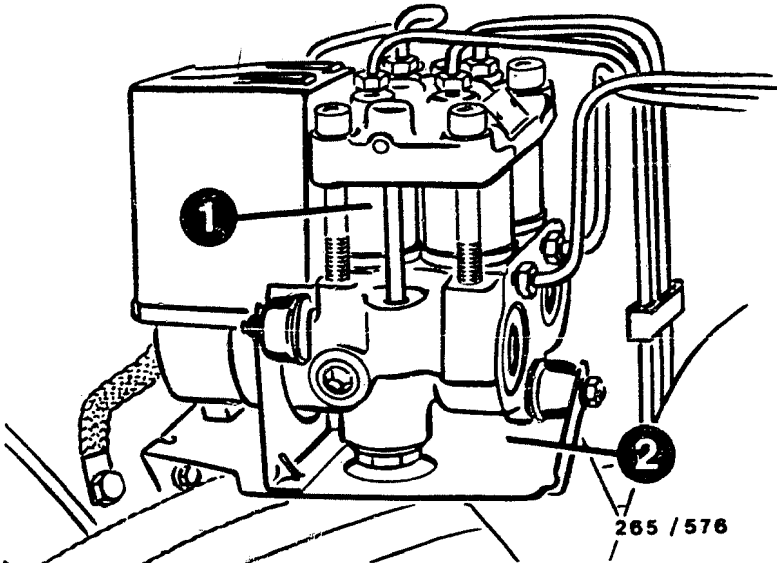
RAPID DIAGNOSIS CHART (CONTINUED)

Program-switch position 1 (4-channel hydraulic modulator)

Testing of (measurement at terminals)	Addition- al operation	Test specifi- cation (reading)	Possible causes of faults
Ground connection (term.10, term.34) Diode for warning lamp (term.29, term.32) Solenoid-operated valve internal res. (term.2, term.18, term.19, term.35) Off-position and ground connection of relay ABS warning lamp	Ignition on	7 LED (1 to 4.4) simultaneously brightly lit (top picture) ABS warning lamp in vehicle must light up	<ul style="list-style-type: none">* LED 1 and/or 2 (top picture) not lit: Check ground terminals for open circuit.* LED 3 (top picture) not lit: Diode defective, check ground connection of valve relay.* One or more LEDs 4 not lit: Check corresponding plug-in connection for solenoid- operated valve and leads.Solenoid-operated valve internal resistance 0,7...1,7 Ω* All LEDs 4 and LEDs 3 not lit: Check ground connection of valve relay, valve relay defective.* Dimmer lighting-up of an LED means contact resistance in the corresponding circuit.* ABS warning lamp not lit: Warning lamp defective. Note: all other 6 LEDs lit.



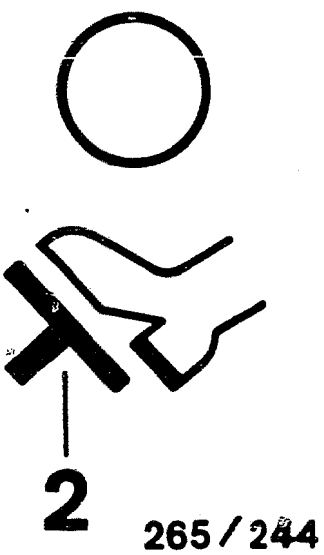
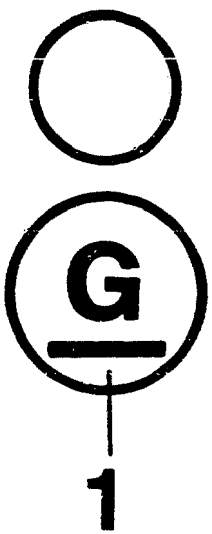
1 = Hydraulic modulator
2 = Mount



RAPID DIAGNOSIS CHART (CONTINUED)

Program-selector-switch position 2

Under test (Measurement at the terminals)	Addition- al operation	Test specifi- cation (reading)	Possible causes of trouble
Alternator voltage from term. 61/D+ (term. 15)	Ignition on	LED 1 (top picture) lit.	* In some cases, LED does not go out until after burst of throttle (test is O.K. in this case).
	Start engine	LED 1 (top picture) goes out when engine running	* Test lead and signal from alternator term. 61/D+ * Alternator defective.
Stop-lamp switch (term.25)	Ignition on	LED 2 (top picture) lit	* Stop-lamp switch defective. * Check lead to stop-lamp switch.
	Press brake pedal	LED 2 (top picture) goes out	* Lead incorrectly connected to to stop-lamp switch.

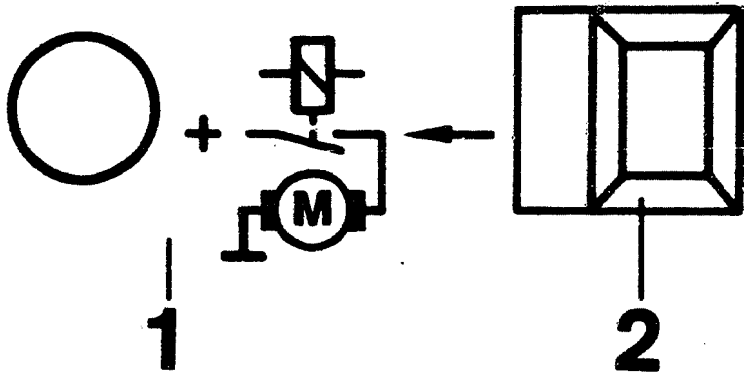


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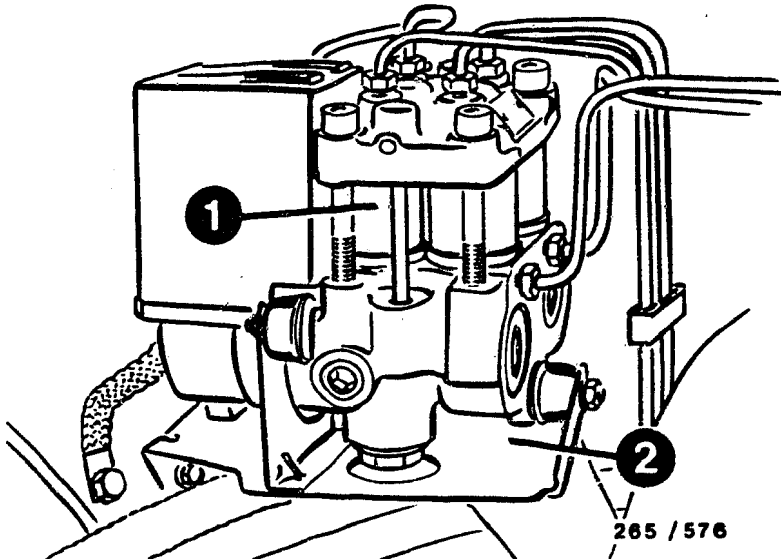
RAPID DIAGNOSIS CHART (CONTINUED)

Program-selector-switch position 3

Testing of (measurement at terminals)	Additional operation	Test specifi- cations (indication)	Possible causes of trouble
Motor relay, pump motor in hydraulic modulator (term.14 and term.28)	Ignition on, press button 2 continuously (Top picture)	LED 1 lights up, pump motor runs. After releasing button, LED lights up as a result of motor run-on (top picture).	<ul style="list-style-type: none">* Motor relay defective* Check ground connection and positive terminal of pump motor* Check following leads: From controller term.14 and term.28 to hydraulic modulator term.9 and term.11. Positive leads to hydraulic modulator term.2 and term.13.* Pump motor or hydraulic modulator defective.



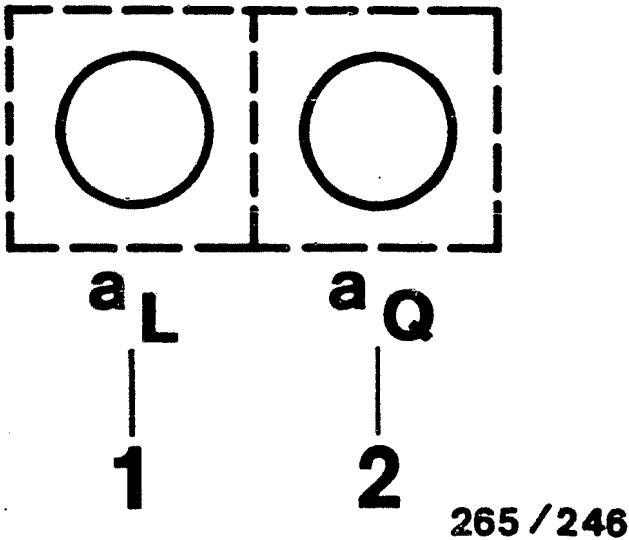
1 = Hydraulic modulator
2 = Mount



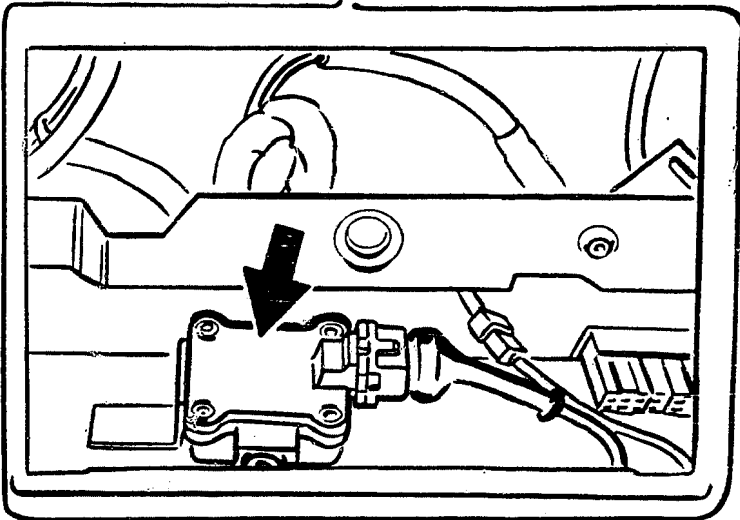
RAPID DIAGNOSIS CHART (CONTINUED)

Program-selector-switch position 4

Testing of (measurement at terminals)	Addition- al operation	Test specifi- cation (indication)	Possible causes of trouble
Acceleration switch a L (term.16)	Ignition on	LED a L lights up	<div><div>* Check acceleration switch: resistance: 500...670 Ω</div><div>Pay attention to correct install- ation position when fitting switch: Arrow in direction of travel.</div><div>* Check lead from acceleration switch to ABS controller term.16.</div><div>* Check lead from controller term.1 to acceleration switch.</div></div>



Arrow = Acceleration switch

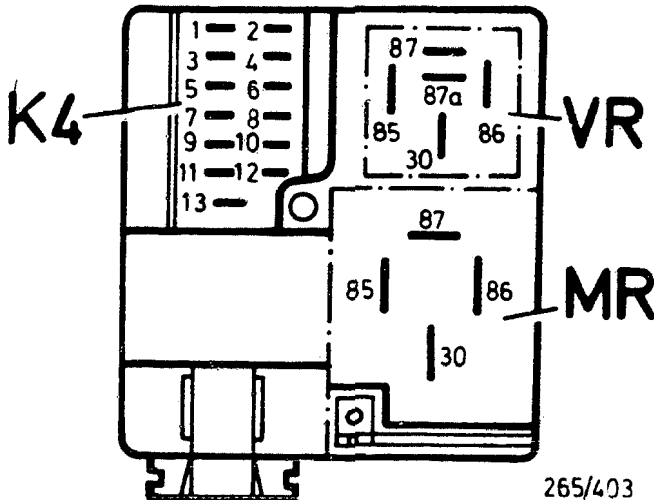
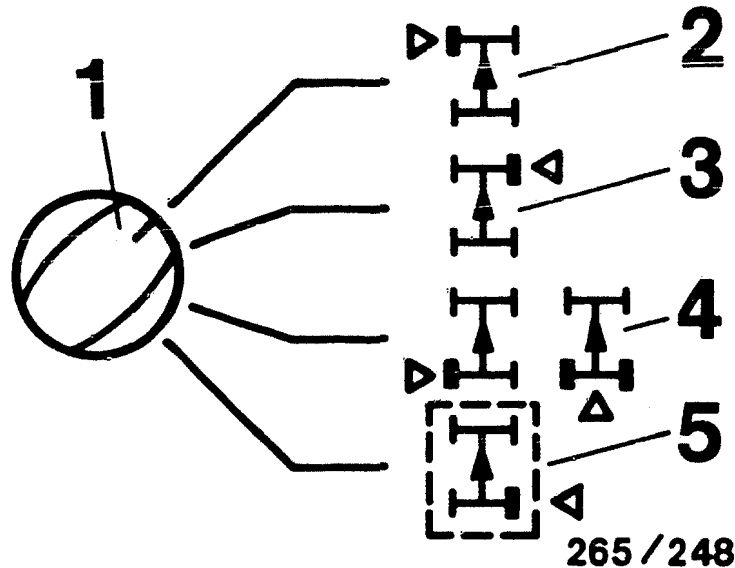
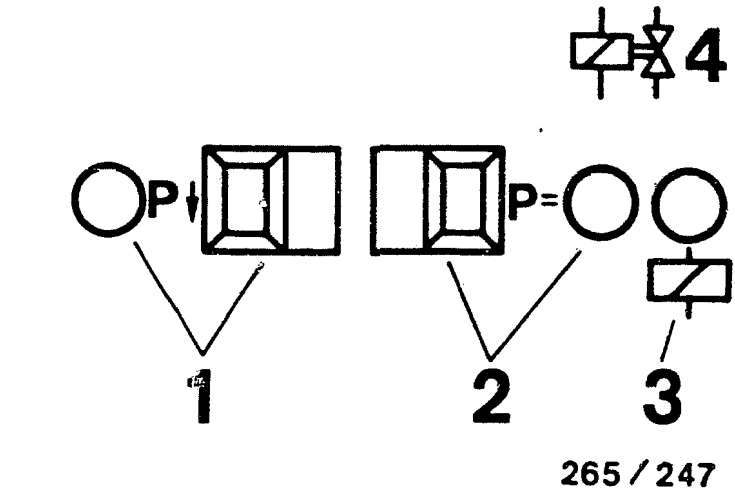


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RAPID DIAGNOSIS CHART (CONTINUED)

Program-selector-switch position 5 (4-channel hydraulic modulator)

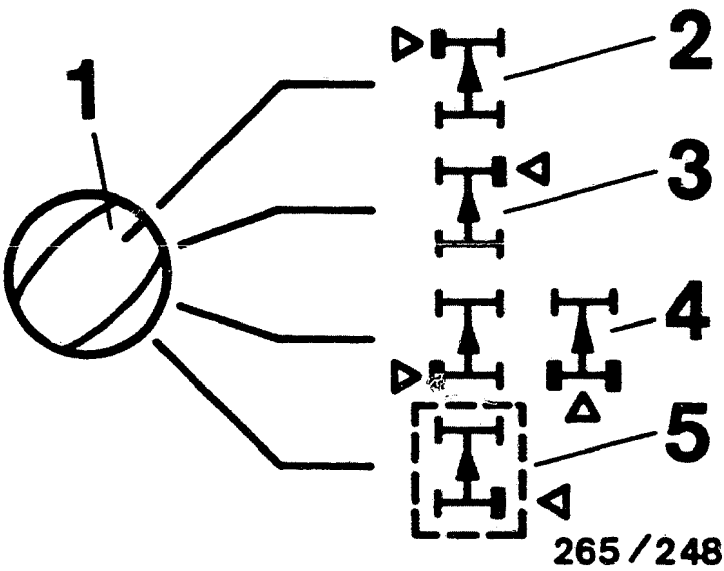
Under test (measurement at the terminals)	Additional operation	Test specification (reading)	Possible causes of trouble
Valve relay operation (term. 27)	Ignition on	LED 3 (upper illustration) lights up	*Valve relay (winding) or leads defective
Solenoid-operated valves in hydraulic modulator for operation and and mix-up. NOTE: Check each wheel separately in turn. Keep to operating sequence.	Chock up vehicle. Ignition on. The wheel being tested must be freely turnable by hand. Set switch 1 for wheel selection to wheel to be tested (center illustration).		* Repeat test with engine running * Valve relay (make contact) defective * Break in lead from valve relay term. 87 to B+ * Brake leads at hydraulic modulator mixed up
Operation, pressure holding	1. Constantly press push-but. P = (upper illustration)	LED P= (upper illustration lights up)	* Current value not obtained (LED P arrow or P= goes out; upper illustration): battery insufficiently charged. Repeat check with engine running.
	2. Constantly press brake pedal	Wheel turnable by hand	
	3. Release push-button P = (upper illustration)	LED P= goes out (upper illustration) Wheel locks	
Operation, pressure reduction	4. Press push-button P arrow (upper illustration)	LED P arrow (upper illustration) lights up, wheel turnable by hand	* Solenoid-operated valves correctly connected electrically? Wheel, front left: term.2 Wheel, front right: term.35 Wheel, rear left: term.18 Wheel, rear right: term.19 Rear axle: term. - * Hydraulic modulator defective
	5. Release push-button P arrow (upper illustration)	LED P arrow (upper illustration) goes out, wheel locks	
	6. Release brake pedal		



RAPID DIAGNOSIS CHART (CONTINUED)

Program-selector-switch position 6 (4 wheel-speed sensors)

Under test (measurement at the terminals)	Additional operation	Test specification (reading)	Possible causes of trouble
<p>Wheel-speed sensor for operation and mix-up</p> <p>NOTE: Check each wheel separately in turn.</p> <p>Wheel, front left: term.4 and t.5(22)</p> <p>Wheel, front right: term.11 and term.21</p> <p>Wheel, rear left: term.7 and term.9</p> <p>Wheel, rear right: term.24 and term.26</p>	<p>Chock-up vehicle. Ignition on.</p> <p>The wheel being tested must be freely turn- able by hand.</p> <p>When testing the driven axle, the wheel not being tested must be locked.</p> <p>Set switch for wheel selection to wheel to be tested (lower illustration)</p> <p>Turn wheel by hand until LED 2 above instrument lights up without flickering. (Wheel speed approx. 1 revolution per second). Afterwards, read off indication at instrument: (upper illustration)</p>	<p>1. Smallest reading larger 1,6 divisions</p> <p>2. Permissible fluctuation max. 25 % of largest reading.</p>	<p>*Wheel-speed-sensor lead mixed up</p> <p>*Brake in wheel-speed- sensor lead</p> <p>*Wheel-speed sensor defective</p> <p>Winding resistance Front axle: 0,6...1,6 k Ω</p> <p>Rear axle: 0,6...1,6 k Ω</p> <p>*Air gap between wheel- speed sensor and ring gear too wide</p> <p>*Ring gear defective (e.g. corroded, dirty) or loose.</p> <p>*Ring gear with incorrect number of teeth installed Front axle: 48 teeth Rear axle: 48 teeth</p> <p>*Wheel-bearing clearance too large</p> <p>*Instrument gives reading, LED 2 does not light up: loose contact in wheel- speed sensor lead.</p>



TEST SPECIFICATIONS

Wheel-speed sensor

- * Winding resistance at ambient temperature (-10°C...+120°C) for front wheels: 600...1600 Ω
- rear wheels: 600...1600 Ω

Hydraulic-modulator solenoid valves

- * Winding resistance at ambient temperature (-10°C...+120°C): 0,7... 1,7 Ω

Air gap between wheel-speed sensor and ring gear

- * at front wheels: 0,1...0,8 mm
- * at rear wheels: 0,1...1,3 mm

Tightening torque for

- * fastening screws of wheel-speed sensors: > 8 Nm
- * Brake-line connections at hydraulic modulator: 12...16 Nm
- * Fastening screws for wheel-speed-sensor mount
 - at front wheels: 25 Nm
 - at rear wheels: 40 Nm

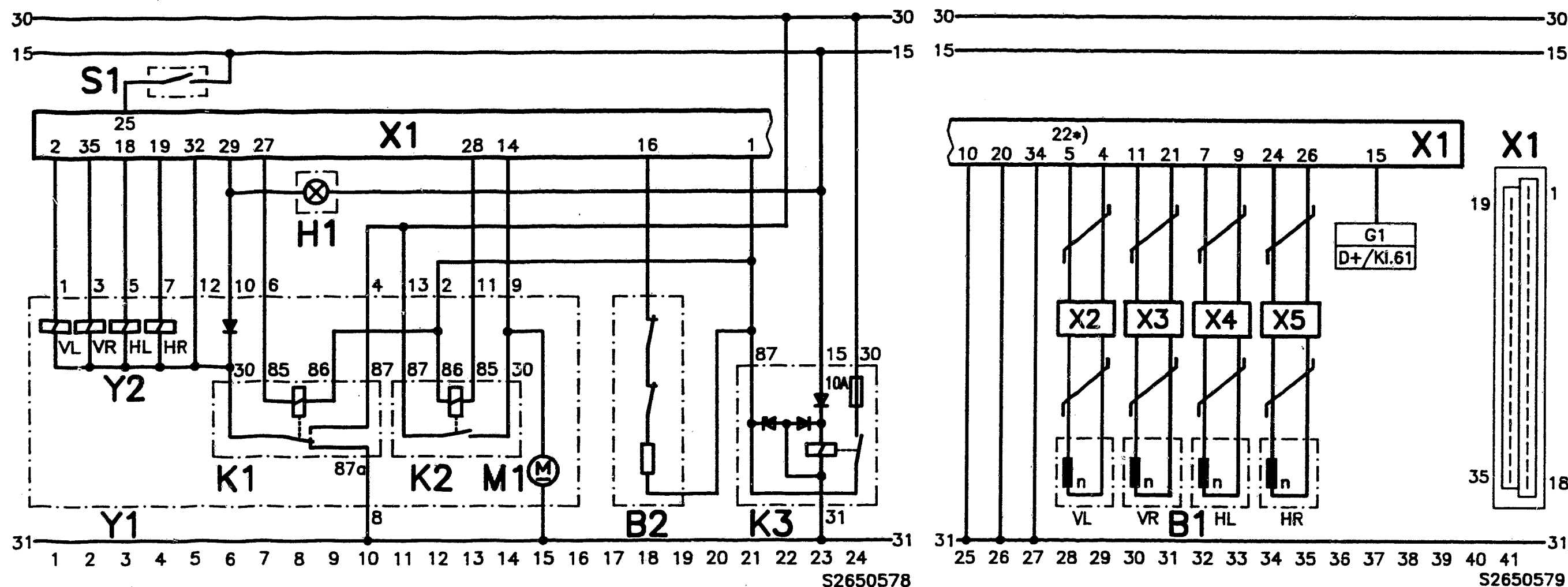
Number of teeth on wheel-speed-sensor ring gears

- * at front wheels: 48 teeth
- * at rear wheels: 48 teeth

Lateral acceleration sensor

- * Contacts closed in horizontal position: 500... 670 Ω

For production reasons:
continued on the following
coordinate.

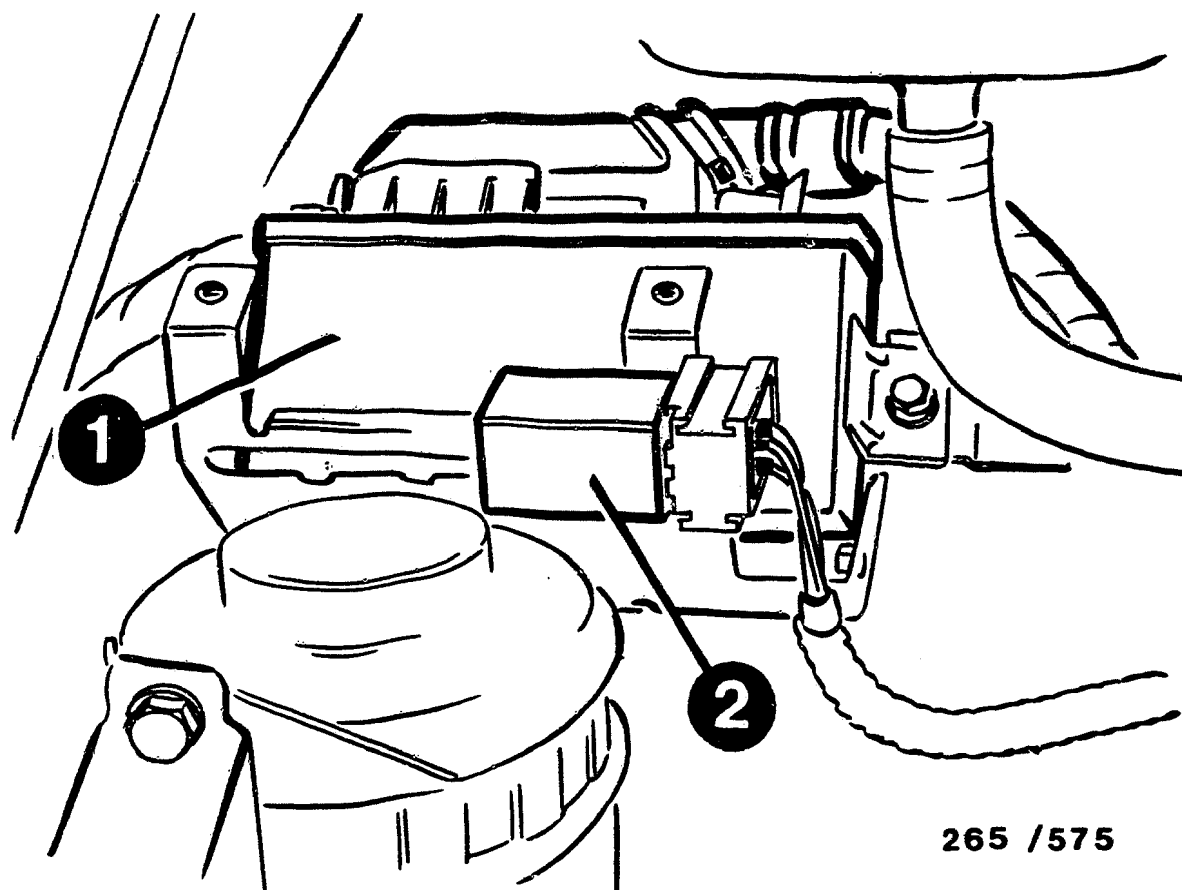


ELECTRICAL TERMINAL DIAGRAM

B1 = Wheel-speed sensor
 B2 = Acceleration switch
 (4-WD only)
 G1 = to alternator via
 charge indicator lamp
 H1 = ABS warning lamp
 K1 = Valve relay

K2 = Engine relay
 K3 = Over-voltage protection
 relay
 M1 = Return pump motor
 S1 = Stop-lamp switch
 X1 = Controller plug (35-pole)
 X2...X5 = Wheel-speed-sensor plugs

Y1 = Hydraulic modulator
 Y2 = Solenoid valves
 HL = Rear left
 HR = Rear right
 VL = Front left
 VR = Front right
 *) = Term.22 applies to 4-WD



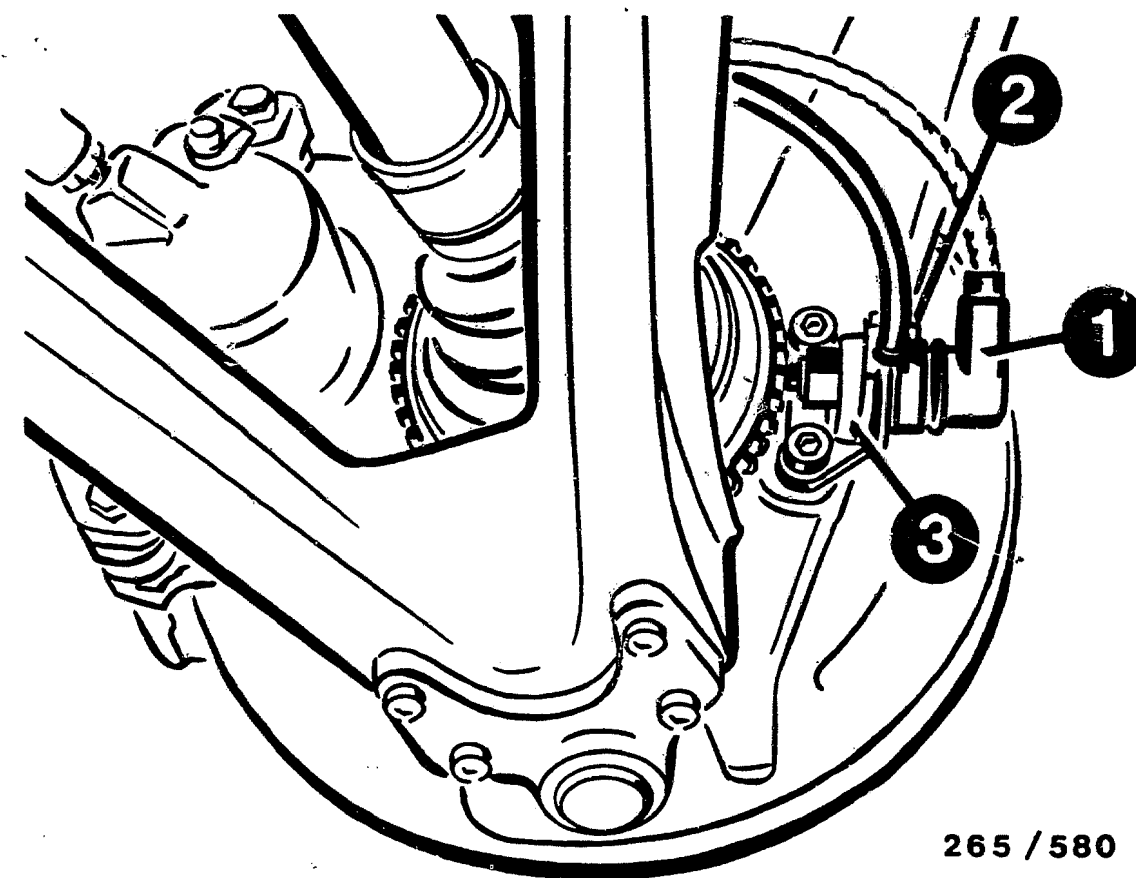
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- 1 = ABS controller
- 2 = Over-voltage protection relay

INSTALLATION POSITION OF COMPONENTS

The installation locations always refer to the direction of travel.

- * ABS controller:
In engine compartment on right beneath expansion tank.
Remove cover over controller.
- * Over-voltage protection relay:
In engine compartment, right at ABS-controller mount.
- * ABS warning lamp:
In instrument panel.
Symbol: Skidding car.

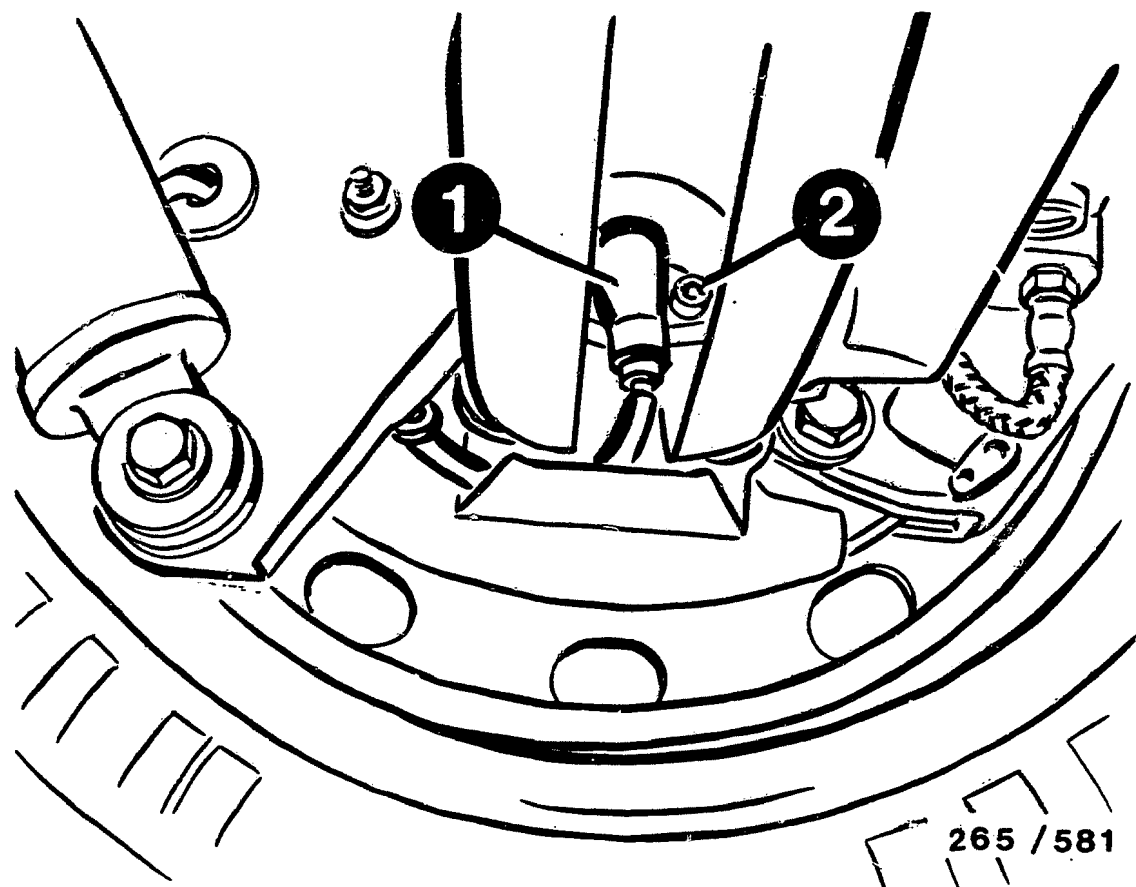


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- 1 = Wheel-speed sensor, front
- 2 = Fastening screw
- 3 = Mount

INSTALLATION POSITION OF COMPONENTS (continued)

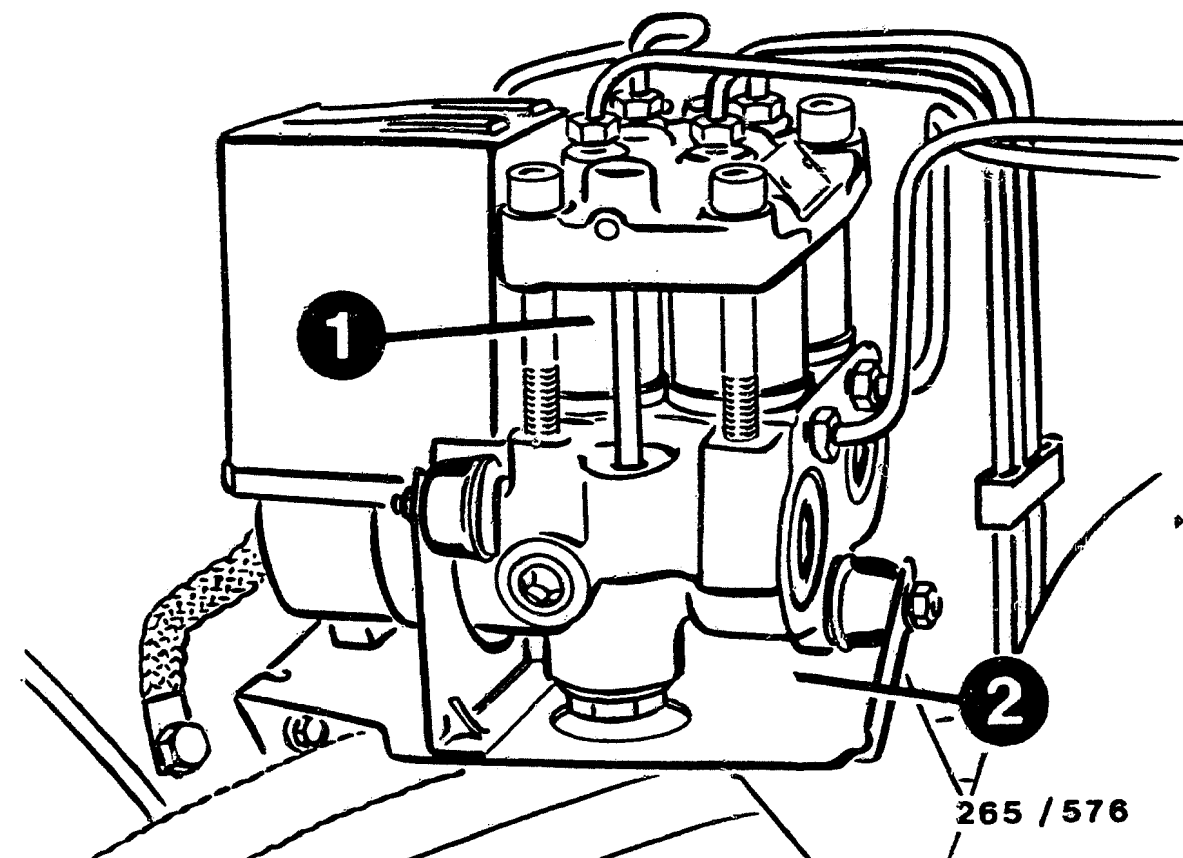
- * Wheel-speed sensor, front axle:
One each on left and right at steering-knuckle brackets.
Do not unscrew mount when removing!
Plug connections on left and right in wheel housings.
- * ABS ground terminal:
At ABS-controller mount.



- 1 = Wheel-speed sensor, rear
with front-wheel drive
2 = Fastening screw

INSTALLATION POSITION OF COMPONENTS (continued)

- * Wheel-speed sensor, rear axle:
One each on left and right at wheels.
Beneath wheel hub with front-wheel drive;
above wheel hub with 4-WD.
Do not unscrew mount when removing!
- Plug connections beneath vehicle on left
and right ahead of rear axle.
- * Pressure reducer:
Beneath vehicle on left behind differential



- 1 = Hydraulic modulator
2 = Mount

INSTALLATION POSITION OF COMPONENTS (continued)

- * Hydraulic modulator:
In engine compartment, right.

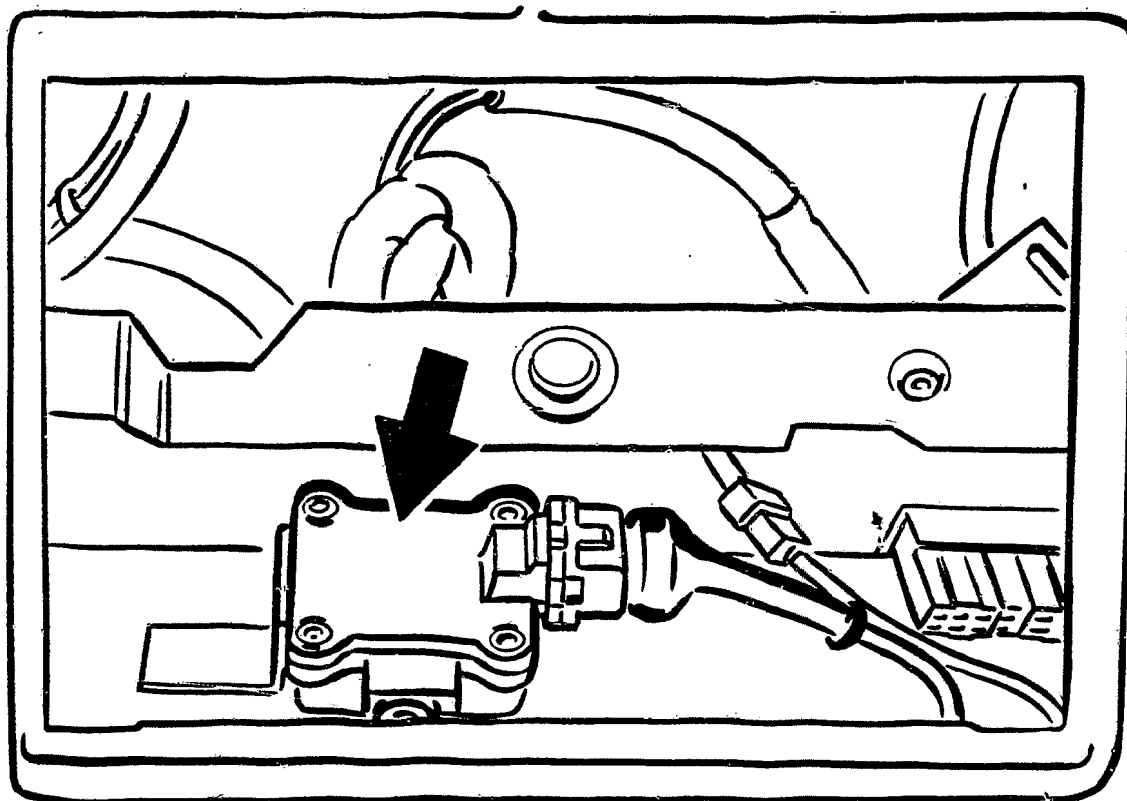
The hydraulic modulator is not to be repaired,
but rather only replaced as a complete unit.
Exception: relay change.

For assembly work and for changing relay,
loosen hydraulic-modulator mount and lower
somewhat to front.

Do not mix up brake-line connections!
Pay attention to assignment.

Color code:

yellow = VL (front left),
green = VR (front right),
blau = HL (rear left),
red = HR (rear right).



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Arrow = Acceleration switch

INSTALLATION POSITION OF COMPONENTS (continued)

- * Acceleration switch:
On mount at center tunnel beneath radio.
Remove radio.
When installing:
Arrow on switch must point in direction
of travel. Attach without washers.

For production reasons:
continued on the following
coordinate.

Trouble-shooting instructions : ROV-5000

BOSCH system : ABS

Make of vehicle : ROVER

Basic microcard : KFZ-00..

TABLE OF CONTENTS

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Electrical terminal diagram	19
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SPECIAL FEATURES

This microcard, valid at the time of publication, contains trouble-shooting instructions for the following models:

AUSTIN ROVER

825 Si, Sterling 10.86->

827 Si (L), Sterling 2.88->

- * ABS with 4 wheel-speed sensors and 4 hydraulic channels.
- * Sensor ring gear with 45 teeth.
- * Front-axle wheel-speed sensors attached to intermediate plate.

STRUCTURE, USAGE

These brief instructions encompass essentially vehicle-specific special features and test specifications (set values).

For a detailed description of trouble-shooting, see the basic instructions.

ATTENTION :

The set values, terminal assignments and special features of these vehicle-specific brief instructions are always binding.

SAFETY AND PRECAUTIONARY MEASURES

- * For safety reasons, the hydraulic modulator must not be repaired, but be exchanged as a complete unit.
Exception: relays.
- * Do not loosen any screws on the hydraulic modulator!
Danger of fatal accident due to brake failure.
- * Caution when handling brake fluid.
Poisonous!

For further information, see basic instructions.

TEST REQUIREMENTS FOR TESTING WITH ABS2 LED TESTER

- * Regulatory tire size fitted?
- * Check for firm seating of ground of return-supply pump.
- * Check for firm seating and corrosion of ground of overvoltage-protection relay term. 31.
- * Check for firm seating of ground strap between engine block and vehicle frame.
- * Check for leaks in hydraulic connections at hydraulic modulator and sealing points (visual examination).
- * If the ABS warning lamp lights up intermittently when driving (e.g. after switching on loads) and goes out again by itself, check the battery and power supply (alternator, regulator and voltage drops).
- * If the ABS warning lamp lights up constantly and does not go out, check the following points:
 - Controller plug sitting correctly on controller and latched?
 - All plug contacts O.K.?
 - Spring contacts latched?
 - Check installation position for correct seating of seal ring in controller plug. rounded side downward.

- Check wheel-speed-sensor leads for correct assignment at controller plug:

Wheel-speed sensors:

front left to term. 5 and term. 4.
front right to term. 11 and term. 21.
rear left to term. 7 and term. 9.
rear right to term. 24 and term. 26.
rear axle to term. - and term. -.

- V-belt snapped?
(Alternator provides no voltage, charge-indicator lamp and ABS warning lamp light up).
- * Connect ABS 2 LED tester to ABS wiring harness.
- Disconnect and connect controller only with ignition switched off.
- For testing, switch on ignition in all program-selector-switch positions (tester operates with current supply from vehicle battery).
- Observe LED (green) for current supply in all program-selector-switch positions.

CAUTION !

Do not drive with tester connected!

The brake system must be bled of air before the ABS test. Do not activate the ABS tester while the system is being bled.

Repeat the complete test program after any repairs are carried out.

The Antiskid System is a vehicle safety system.

Work on the system demands detailed knowledge of the system.

The conventional brake system must be O.K.

General information for trouble-shooting:

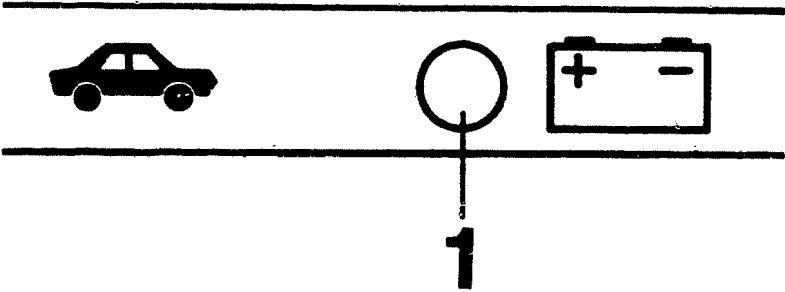
Check all leads for short circuit to ground and contact with positive leads and watch out for worn cable insulation and pinched leads.

RAPID DIAGNOSIS CHART

Do not drive with tester connected. Are all test conditions met?

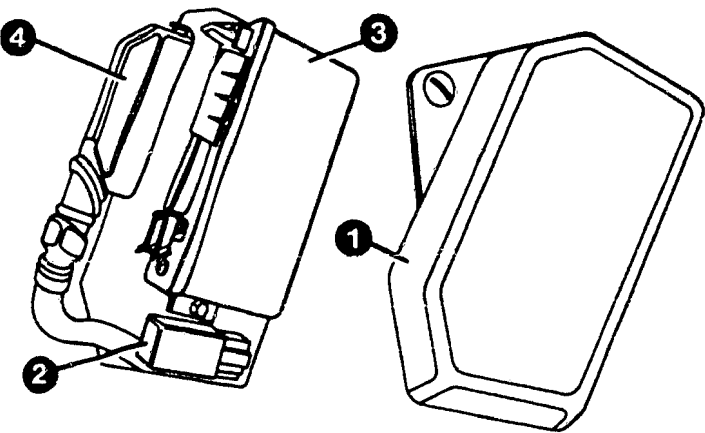
Program-switch positions 1 to 6

Testing of (measurement at terminals)	Additional operation	Test specifi- cation (reading)	Possible causes of faults
Power supply (term.1 und term.20)	Ignition on	LED 1 (top picture) continuously lit	<ul style="list-style-type: none">*Battery insufficiently charged*High voltage drops*Overvoltage-protection relay defective*Check lead to ignition and starting switch, term. 15



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- 1 = Cover
- 2 = Over-voltage protection relay
- 3 = ABS controller
- 4 = Controller plug

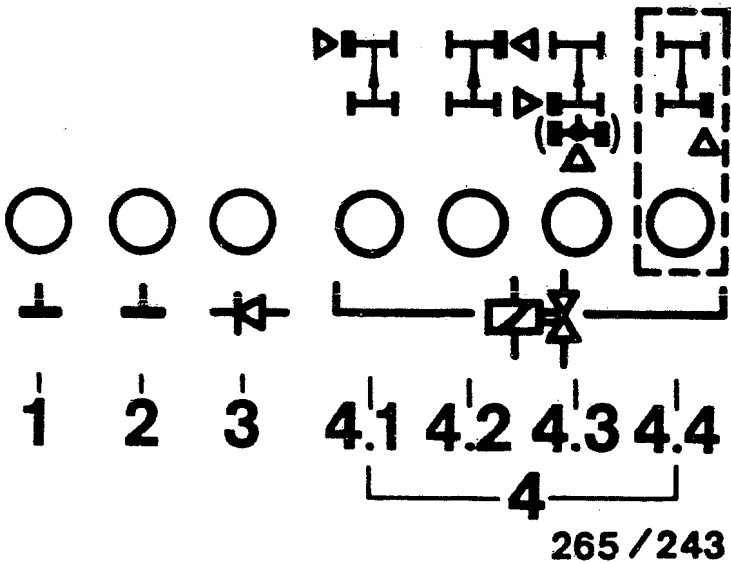


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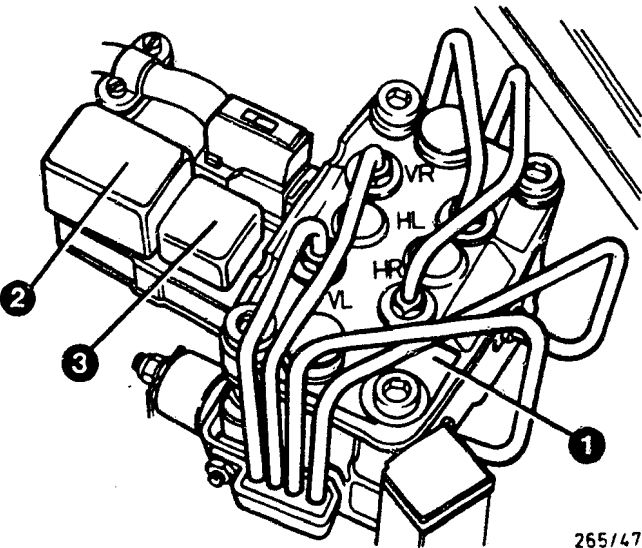
RAPID DIAGNOSIS CHART (CONTINUED)

Program-switch position 1 (4-channel hydraulic modulator)

Testing of (measurement at terminals)	Addition- al operation	Test specifi- cation (reading)	Possible causes of faults
Ground connection (term.10, term.34) Diode for warning lamp (term.29, term.32) Solenoid-operated valve internal res. (term.2, term.18, term.19, term.35) Off-position and ground connection of relay ABS warning lamp	Ignition on	7 LED (1 to 4.4) simultaneously brightly lit (top picture) ABS warning lamp in vehicle must light up	<ul style="list-style-type: none">* LED 1 and/or 2 (top picture) not lit: Check ground terminals for open circuit.* LED 3 (top picture) not lit: Diode defective, check ground connection of valve relay.* One or more LEDs 4 not lit: Check corresponding plug-in connection for solenoid-operated valve and leads.Solenoid-operated valve internal resistance 0,7...1,7 Ω* All LEDs 4 and LEDs 3 not lit: Check ground connection of valve relay, valve relay defective.* Dimmer lighting-up of an LED means contact resistance in the corresponding circuit.* ABS warning lamp not lit: Warning lamp defective. Note: all other 6 LEDs lit.



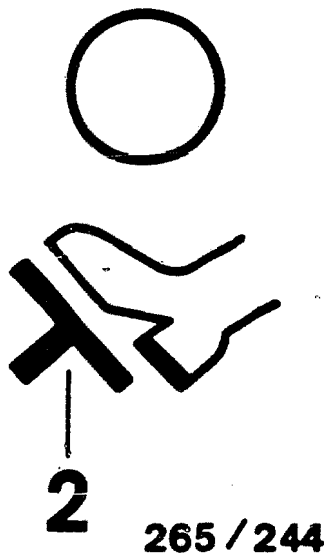
- 1 = Hydraulic modulator
- 2 = Motor relay
- 3 = Valve relay



RAPID DIAGNOSIS CHART (CONTINUED)

Program switch setting 2

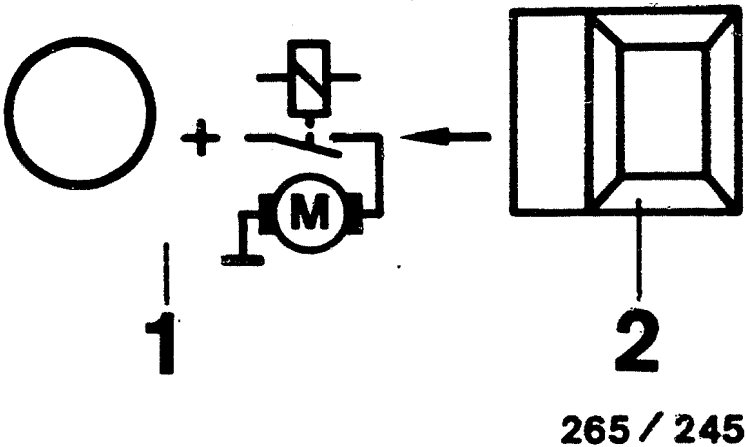
Testing of (measurement at terminals)	Addition- al operation	Test specifica- tion (indication)	Possible causes of fault
Alternator voltage of term.61 (term.15)	Ignition on	LED 1 (top picture) lights up.	* LED sometimes only goes out after accelerating (test is thus O.K.)
	Start engine	LED 1 (top picture) goes out when engine running	* Test lead to alternator term.61 * Alternator defective.
Brake-light switch (term.25)	Ignition on	LED 2 (top picture) lights up	* Brake-light switch defective. * Test lead to brake-light switch.
	Depress brake pedal	LED 2 (top picture) goes out	* Lead incorrectly connected to brake-light switch.



RAPID DIAGNOSIS CHART (CONTINUED)

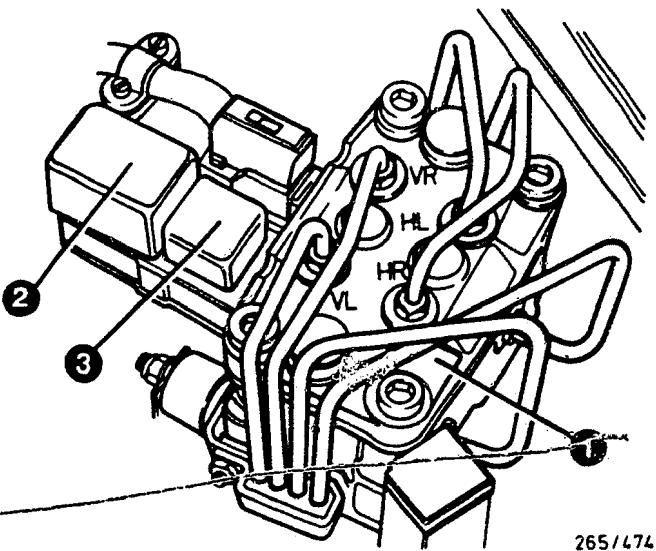
Program-selector-switch position 3

Under test (measurement at the terminals)	Additional operation	Test specification (reading)	Possible causes of trouble
Motor relay, pump motor in hydraulic modulator (term.14 and term.28)	Ignition on, press button 2 contin- uously (top picture)	LED 1 lights up, pump motor runs. After releasing button, LED con- tinues to light due to run-on of motor (top picture).	<ul style="list-style-type: none">* Motor relay defective* Test ground connection and positive terminal of pump motor* Test following leads: From controller term. 14 and term. 28 to hydraulic modulator term. 9 or term. 11. Positive leads to hydraulic modulator term. 2 and term. 13.* Pump motor or hydraulic modulator defective.



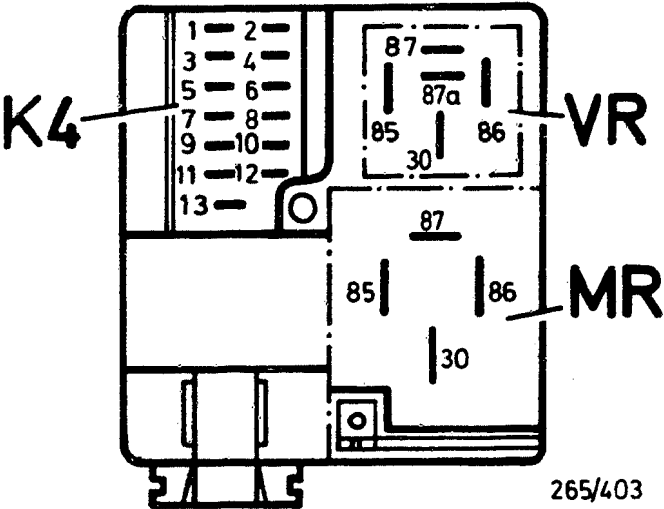
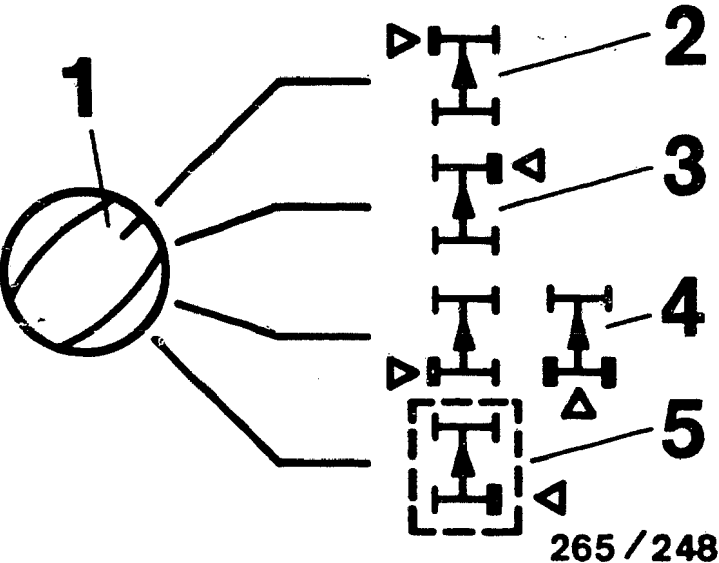
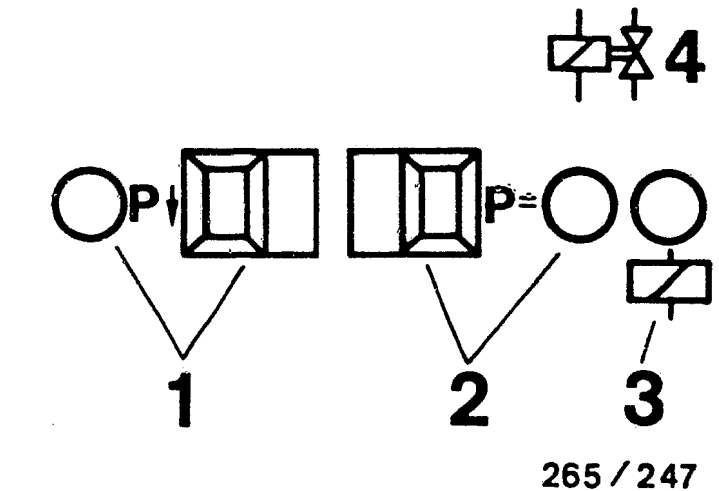
Program-selector-switch position 4 does not apply.

- 1 = Hydraulic modulator
- 2 = Motor relay
- 3 = Valve relay



RAPID DIAGNOSIS CHART (CONTINUED)
 Program-selector-switch position 5 (4-channel hydraulic modulator)

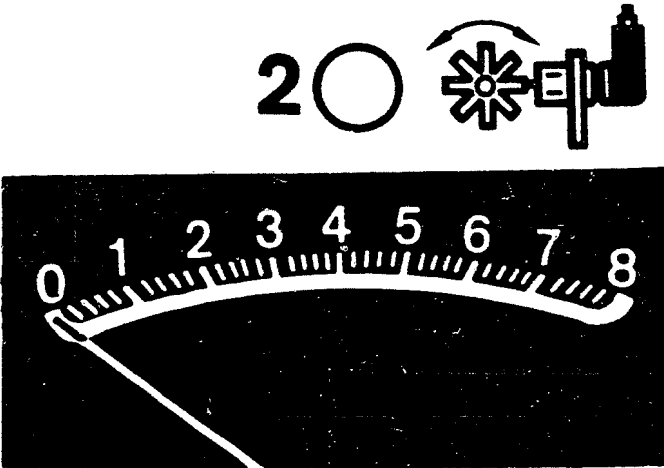
Under test (measurement at the terminals)	Additional operation	Test specification (reading)	Possible causes of trouble
Valve relay operation (term. 27)	Ignition on	LED 3 (upper illustration) lights up	*Valve relay (winding) or leads defective
Solenoid-operated valves in hydraulic modulator for operation and mix-up. NOTE: Check each wheel separately in turn. Keep to operating sequence.	Chock up vehicle. Ignition on. The wheel being tested must be freely turnable by hand. Set switch 1 for wheel selection to wheel to be tested (center illustration).		* Repeat test with engine running * Valve relay (make contact) defective * Break in lead from valve relay term. 87 to B+ * Brake leads at hydraulic modulator mixed up
Operation, pressure holding	1. Constantly press push-but. P = (upper illustration)	LED P= (upper illustration) lights up	* Current value not obtained (LED P arrow or P= goes out; upper illustration); battery insufficiently charged. Repeat check with engine running.
	2. Constantly press brake pedal	Wheel turnable by hand	
	3. Release push-button P = (upper illustration)	LED P= goes out (upper illustration) Wheel locks	
Operation, pressure reduction	4. Press push-button P arrow (upper illustration)	LED P arrow (upper illustration) lights up, wheel turnable by hand	* Solenoid-operated valves correctly connected electrically? Wheel, front left: term.2 Wheel, front right: term.35 Wheel, rear left: term.18 Wheel, rear right: term.19 Rear axle: term. - * Hydraulic modulator defective
	5. Release push-button P arrow (upper illustration)	LED P arrow (upper illustration) goes out, wheel locks	
	6. Release brake pedal		



RAPID DIAGNOSIS CHART (CONTINUED)

Program-selector-switch position 6 (4 wheel-speed sensors)

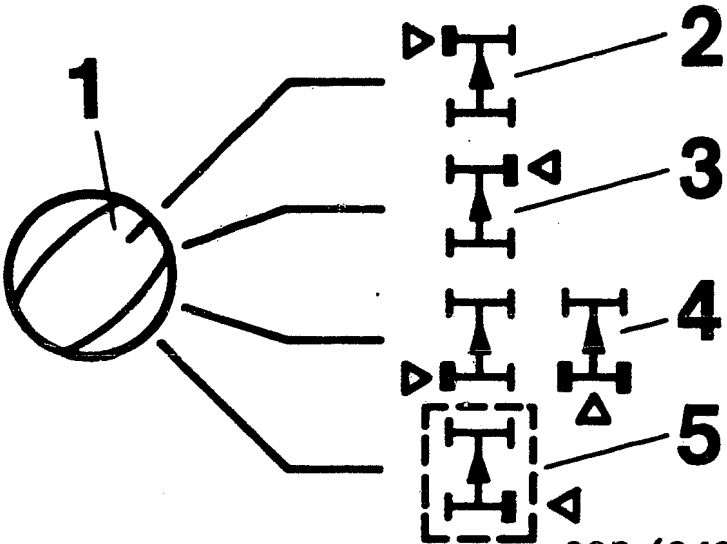
Under test (measurement at the terminals)	Additional operation	Test specification (reading)	Possible causes of trouble
<p>Wheel-speed sensor for operation and mix-up</p> <p>NOTE: Check each wheel separately in turn.</p> <p>Wheel, front left: term4 and t.5</p> <p>Wheel, front right: term.11 and term.21</p> <p>Wheel, rear left: term.7 and term.9</p> <p>Wheel, rear right: term.24 and term.26</p>	<p>Chock-up vehicle. Ignition on.</p> <p>The wheel being tested must be freely turn- able by hand.</p> <p>When testing the driven axle, the wheel not being tested must be locked.</p> <p>Set switch for wheel selection to wheel to be tested (lower illustration)</p> <p>Turn wheel by hand until LED 2 above instrument lights up without flickering. (Wheel speed approx. 1 revolution per second). Afterwards, read off indication at instrument: (upper illustration)</p>	<p>1. Smallest reading larger 1,6 divisions</p> <p>2. Permissible fluctuation max. 25 % of largest reading</p>	<p>*Wheel-speed-sensor lead mixed up</p> <p>*Brake in wheel-speed- sensor lead</p> <p>*Wheel-speed sensor defective</p> <p>Winding resistance Front axle: 0,6...1,6 k Ω</p> <p>Rear axle: 0,6...1,6 k Ω</p> <p>*Air gap between wheel- speed sensor and ring gear too wide</p> <p>*Ring gear defective (e.g. corroded, dirty) or loose.</p> <p>*Ring gear with incorrect number of teeth installed Front axle: 45 teeth Rear axle: 45 teeth</p> <p>*Wheel-bearing clearance too large</p> <p>*Instrument gives reading, LED 2 does not light up: loose contact in wheel- speed sensor lead.</p>



1

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265 / 249



265 / 248

TEST SPECIFICATIONS

Wheel-speed sensors		
* Winding resistance at ambient temperature (-10°C...+120°C) for front wheels:	600...1600	Ω
rear wheels :	600...1600	Ω

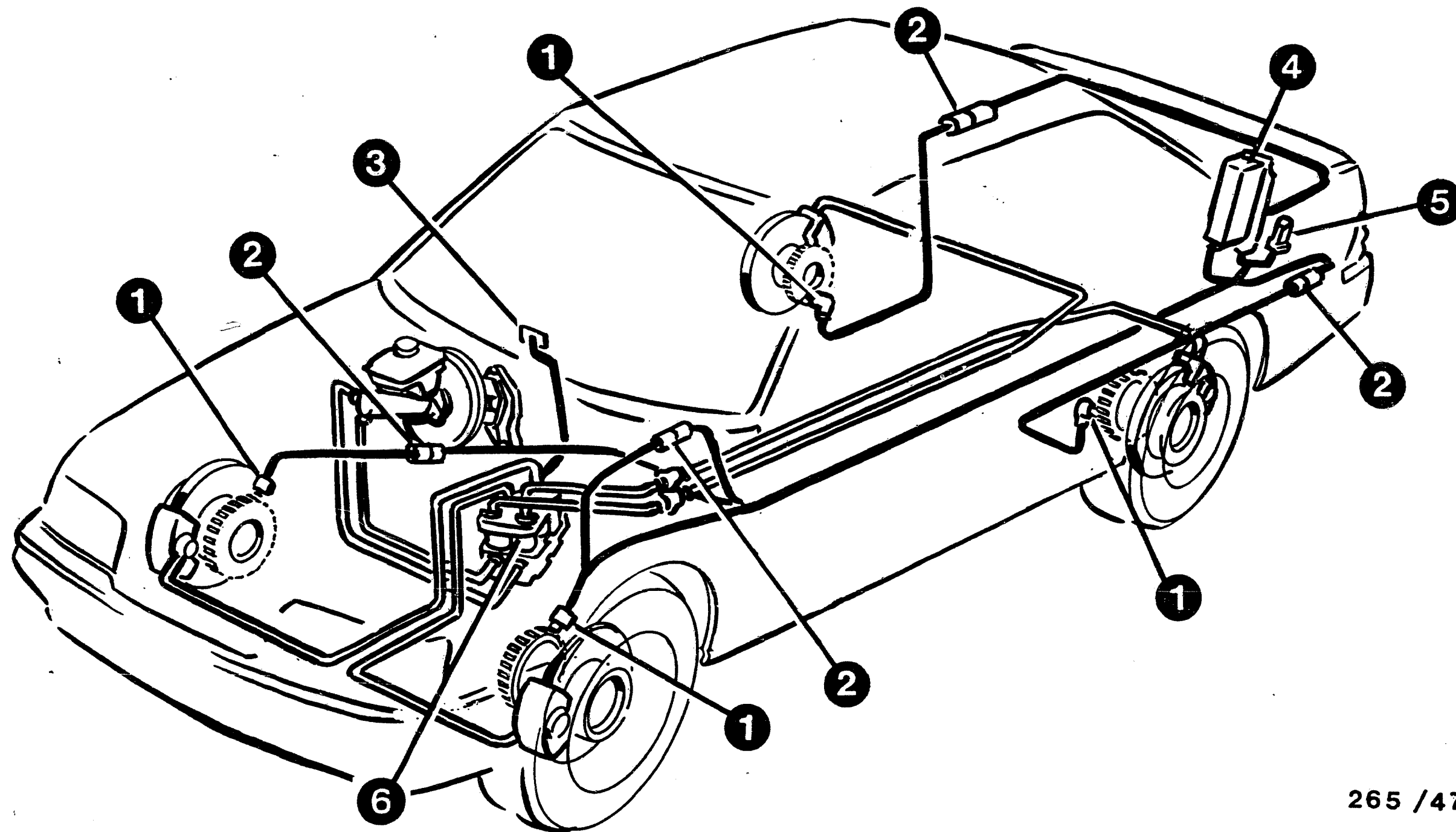
Hydraulic-modulator solenoid valves		
* Winding resistance at ambient temperature (-10°C...+120°C):	0,7...1,7	Ω

Air gap between wheel-speed sensor and ring gear		
* at front wheels:	0,3 ...1,025	mm
* at rear wheels :	0,165...1,035	mm

Tightening torque for		
* fastening screws of wheel-speed sensors:	> 8	Nm
* brake-line connections at hydraulic modulator:	12...16	Nm
* fastening screws for wheel-speed-sensor support at front wheels	25	Nm

Number of teeth on wheel-speed-sensor ring gears		
* at front wheels:	45	teeth
* at rear wheels :	45	teeth

For production reasons:
continued on the following
coordinate.

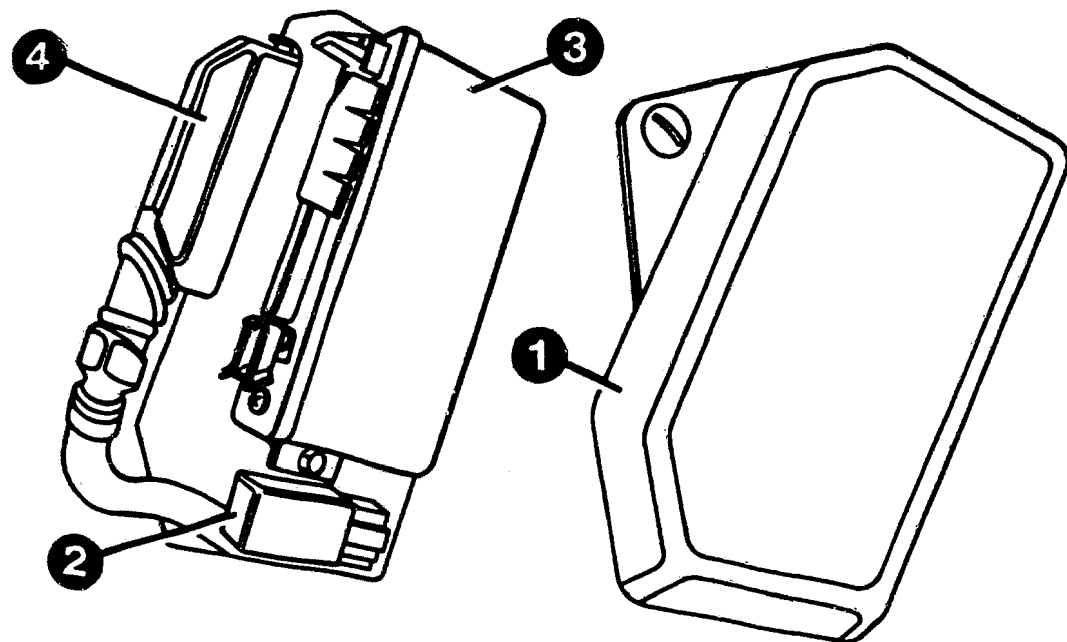


265 /472

1 = Wheel-speed sensor
 2 = Wheel-speed-sensor plug connection
 3 = ABS warning lamp in instrument panel

4 = ABS controller
 5 = Over-voltage protection relay
 6 = Hydraulic modulator

INSTALLATION POSITION OF COMPONENTS



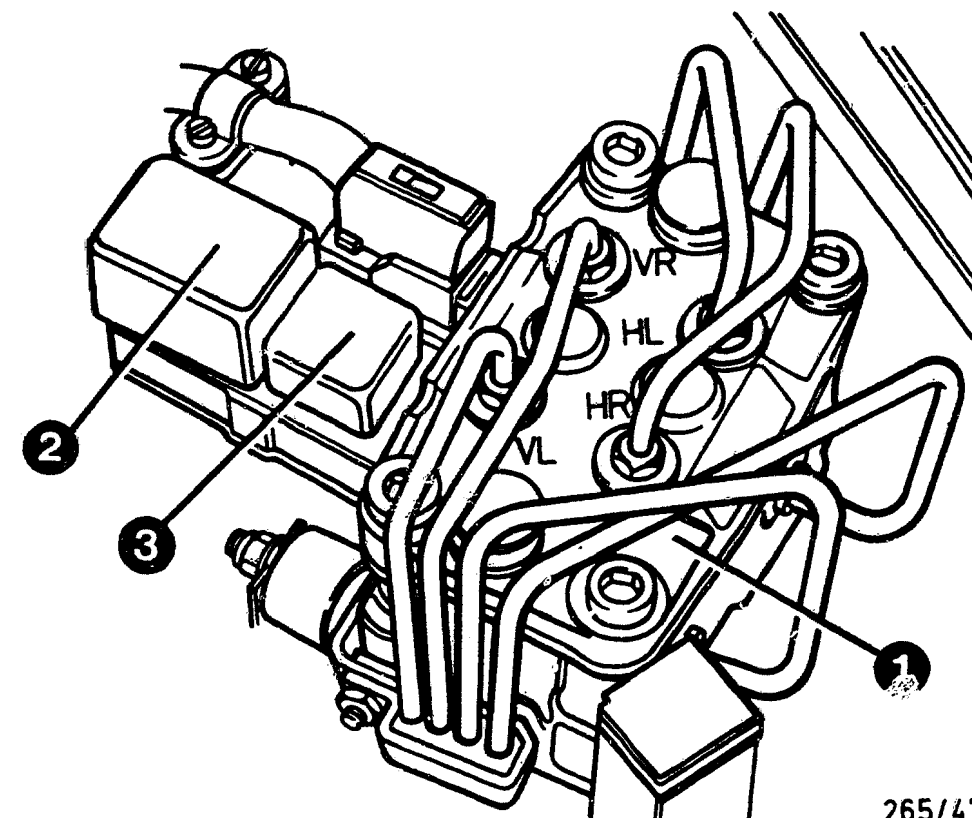
265/473

- 1 = Cover
- 2 = Over-voltage protection relay
- 3 = ABS controller
- 4 = Controller plug

INSTALLATION POSITION OF COMPONENTS (CONTINUED)

The installation locations always refer to the direction of travel.

- * Controller:
On left-hand side of trunk behind cover.
- * Over-voltage protection relay:
On left-hand side of trunk with controller
- * ABS warning lamp: In instrument panel.
Symbol: ABS.
- * Stop-lamp switch:
At brake pedal.



265/474

- 1 = Hydraulic modulator
- 2 = Motor relay
- 3 = Valve relay

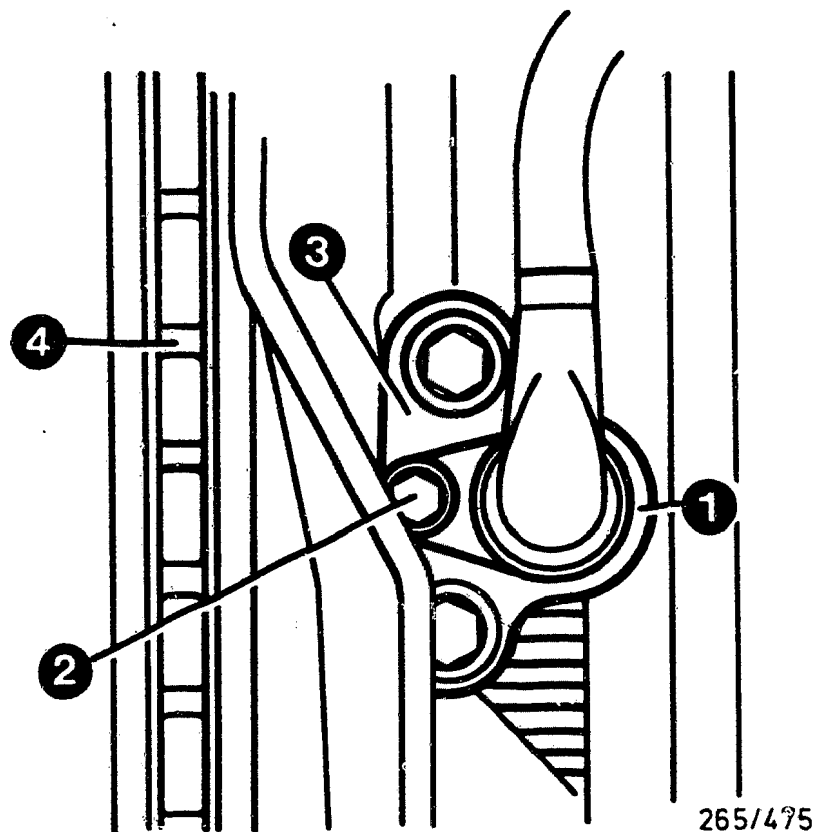
INSTALLATION POSITION OF COMPONENTS (CONTINUED)

- * Hydraulic modulator:
On left-hand side of engine compartment.

The hydraulic modulator is not to be repaired, but rather replaced as a complete assembly.
Exception: Changing relay.

Pay attention to correct assignment of brake-line connections.

- * Ground terminal for pump motor:
In engine compartment at left-hand fender.

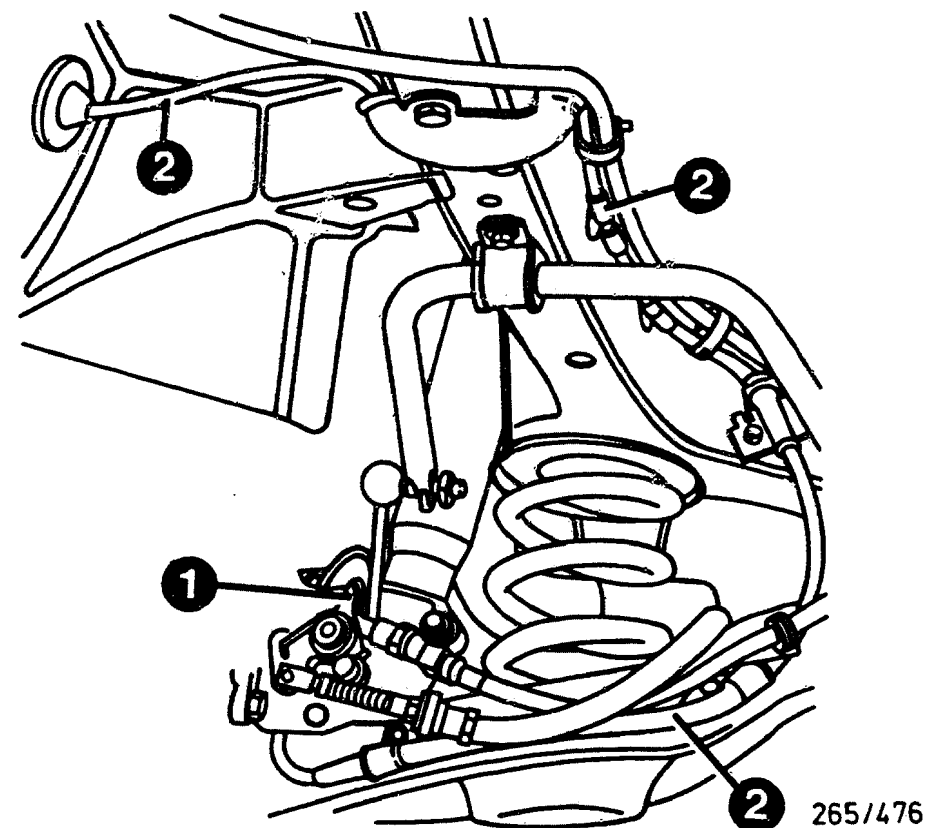


- 1 = Wheel-speed sensor at front wheel
- 2 = Wheel-speed-sensor fastening screw
- 3 = Support
- 4 = Brake disk

INSTALLATION POSITION OF COMPONENTS (CONTINUED)

- * Front-axle wheel-speed sensors:
One each on left and right in steering knuckles.
Do not remove support when removing
wheel-speed sensors!

Wheel-speed-sensor plug connections:
On left-hand side of engine compartment in front of
bulkhead and on right-hand side beneath brake master
cylinder.



- 1 = Wheel-speed sensor (concealed) at rear wheel
- 2 = Wheel-speed-sensor lead

INSTALLATION POSITION OF COMPONENTS (CONTINUED)

- * Rear-axle wheel-speed sensors (cross-pole):
One each on the left and right at the wheels.

Wheel-speed-sensor plug connections:
On left and right in trunk behind
side trim.

Trouble-shooting instructions : VOL-5006
BOSCH system : ABS
Make of vehicle : VOLVO
Basic microcard : KFZ-00..

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Rapid diagnosis chart	07
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SPECIAL FEATURES

This microcard, valid at the time of publication, contains trouble-shooting instructions for the following models:

Volvo 740, 760, 780
09.1987->

- * ABS with 3 wheel-speed sensors and 3 hydraulic channels.
- * New features as of 9.87:
 - **Hydraulic modulator in engine compartment.
 - **Controller in passenger compartment
 - **Wheel-speed-sensor for rear axle:
Installation without shims.
 - **Sensor ring gears with 96 teeth.
- * New features as of 9.88:
 - **Wheel-speed sensor with direct plug connection for rear axle, installation without shims.
 - **Sensor ring gears with 48 teeth.
 - **New controller.
 - **No signal converter for speedometer.
- * New hydraulic modulator 0 265 200 054 as of mid 89:

Hydraulic connections for rear axle (h) and front left (l) converted to M12 x 1, so as to avoid mix-ups.

STRUCTURE, USAGE

These brief instructions encompass essentially vehicle-specific special features and test specifications (set values).

For a detailed description of trouble-shooting, see the basic instructions.

ATTENTION :

The set values, terminal assignments and special features of these vehicle-specific brief instructions are always binding.

SAFETY AND PRECAUTIONARY MEASURES

- * For safety reasons, the hydraulic modulator must not be repaired, but be exchanged as a complete unit.
Exception: relays.
- * Do not loosen any screws on the hydraulic modulator!
Danger of fatal accident due to brake failure.
- * Caution when handling brake fluid.
Poisonous!

For further information, see basic instructions.

For production reasons:
continued on the following
coordinate.

TEST REQUIREMENTS FOR TESTING WITH ABS2 LED TESTER

- * Regulatory tire size fitted?
- * Check for firm seating of ground of return-supply pump.
- * Check for firm seating and corrosion of ground of overvoltage-protection relay term. 31.
- * Check for firm seating of ground strap between engine block and vehicle frame.
- * Check for leaks in hydraulic connections at hydraulic modulator and sealing points (visual examination).
- * If the ABS warning lamp lights up intermittently when driving (e.g. after switching on loads) and goes out again by itself, check the battery and power supply (alternator, regulator and voltage drops).
- * If the ABS warning lamp lights up constantly and does not go out, check the following points:
 - Controller plug sitting correctly on controller and latched?
 - All plug contacts O.K.?
 - Spring contacts latched?
 - Check installation position for correct seating of seal ring in controller plug, rounded side downward.

- Check wheel-speed-sensor leads for correct assignment at controller plug:

Wheel-speed sensors:

front left to term. 6 and term. 4.
front right to term. 23 and term. 21.
rear left to term. — and term. —.
rear right to term. — and term. —.
rear axle to term. 7 and term. 9.

- V-belt snapped?
(Alternator provides no voltage, charge-indicator lamp and ABS warning lamp light up).
- * Connect ABS 2 LED tester to ABS wiring harness.
- Disconnect and connect controller only with ignition switched off.
- For testing, switch on ignition in all program-selector-switch positions (tester operates with current supply from vehicle battery).
- Observe LED (green) for current supply in all program-selector-switch positions.

C A U T I O N !

Do not drive with tester connected!

The brake system must be bled of air before the ABS test. Do not activate the ABS tester while the system is being bled.

Repeat the complete test program after any repairs are carried out.

The Antiskid System is a vehicle safety system.

Work on the system demands detailed knowledge of the system.

The conventional brake system must be O.K.

General information for trouble-shooting:

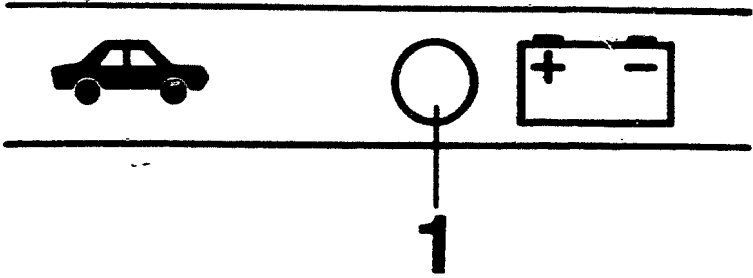
Check all leads for short circuit to ground and contact with positive leads and watch out for worn cable insulation and pinched leads.

RAPID DIAGNOSIS CHART

Never drive with tester connected! Have all test prerequisites been met?

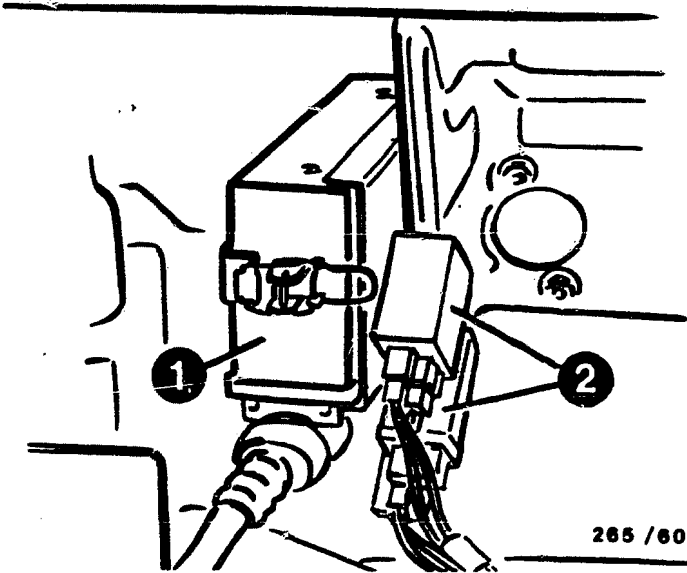
Program-selector-switch settings 1 - 6

Testing of (measurement at terminals)	Additional operation	Test speci- fication (indication)	Possible causes of trouble
Voltage supply (Term.1 and term.20)	Ignition on	LED 1 (top picture) lights up constantly	<ul style="list-style-type: none">* Fuse defective.* Inadequate battery charge.* Excessive voltage dips.* Check leads from relay plug to controller term. 1, to driving switch term. 15, to battery B+ and to ground terminal. Check ground lead to controller term. 20.* Over-voltage protection relay defective.



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1 = ABS controller
2 = Over-voltage protection relay and signal converter

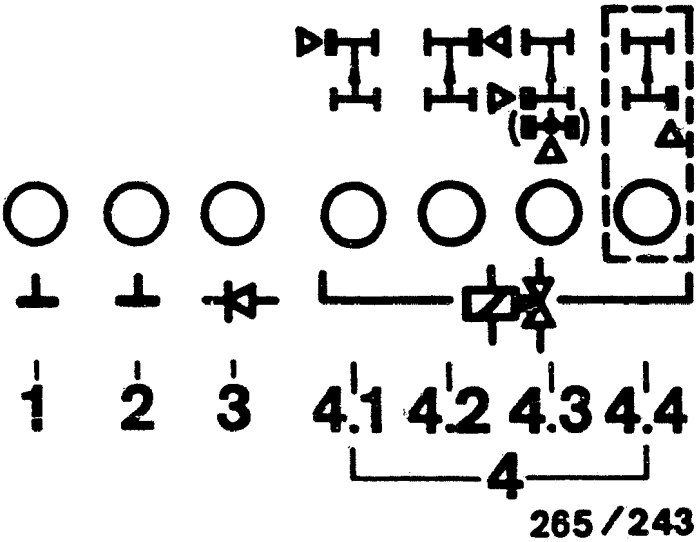


265 / 605

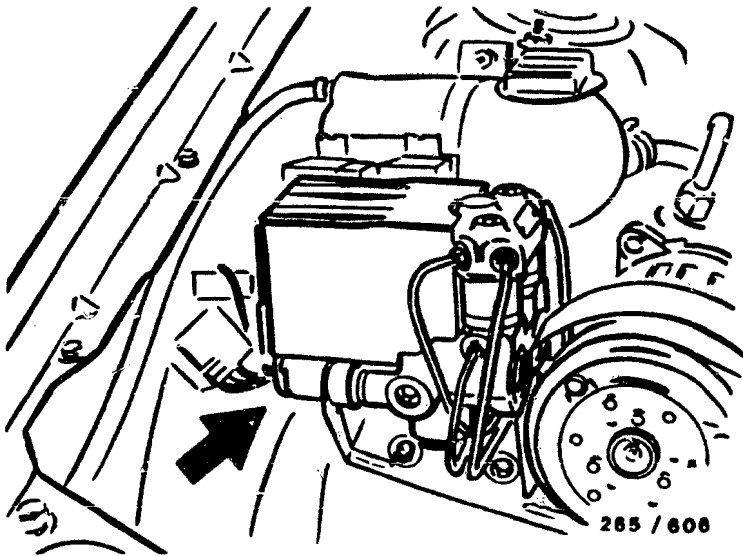
RAPID DIAGNOSIS CHART (CONTINUED)

Program-switch position 1 (3-channel hydraulic modulator)

Testing of (measurement at terminals)	Addition- al operation	Test specifi- cation (reading)	Possible causes of faults
Ground connection (term.10, term.34) Diode for warning lamp (term.29, term.32) Solenoid-operated valve internal res. (term.2, term.18, term.35, term.-) Off-position and ground connection of relay ABS warning lamp	Ignition on	6 LED (1 to 4.3) simultaneously brightly lit (top picture) ABS warning lamp in vehicle must light up	<ul style="list-style-type: none">* LED 1 and/or 2 (top picture) not lit: Check ground terminals for open circuit.* LED 3 (top picture) not lit: Diode defective, check ground connection of valve relay.* One or more LEDs 4 not lit: Check corresponding plug-in connection for solenoid- operated valve and leads.Solenoid-operated valve internal resistance 0,7...1,7 Ω* All LEDs 4 and LEDs 3 not lit: Check ground connection of valve relay, valve relay defective.* Dimmer lighting-up of an LED means contact resistance in the corresponding circuit.* ABS warning lamp not lit: Warning lamp defective. Note: all other 5 LEDs lit.



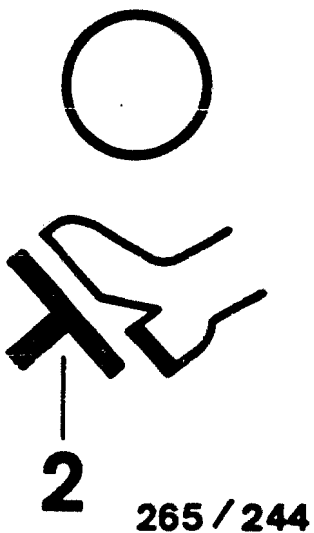
Arrow = Hydraulic modulator



RAPID DIAGNOSIS CHART (CONTINUED)

Program-selector-switch position 2

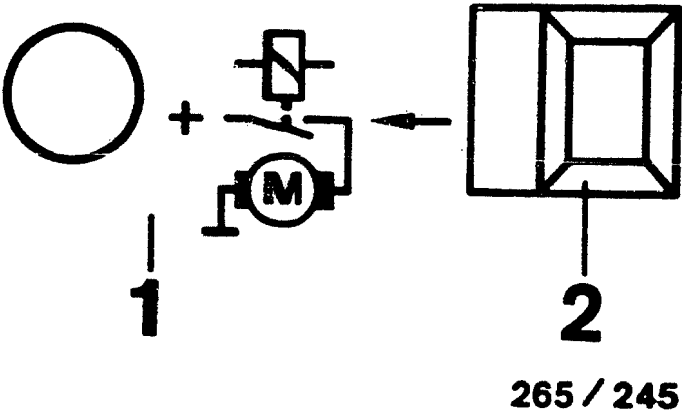
Under test (Measurement at the terminals)	Addition- al operation	Test specifi- cation (reading)	Possible causes of trouble
Alternator voltage from term. 61/D+ (term. 15)	Ignition on	LED 1 (top picture) lit.	* In some cases, LED does not go out until after burst of throttle (test is O.K. in this case).
	Start engine	LED 1 (top picture) goes out when engine running	* Test lead and signal from alternator term. 61/D+ * Alternator defective.
Stop-lamp switch (term.25)	Ignition on	LED 2 (top picture) lit	* Stop-lamp switch defective. * Check lead to stop-lamp switch.
	Press brake pedal	LED 2 (top picture) goes out	* Lead incorrectly connected to to stop-lamp switch.



RAPID DIAGNOSIS CHART (CONTINUED)

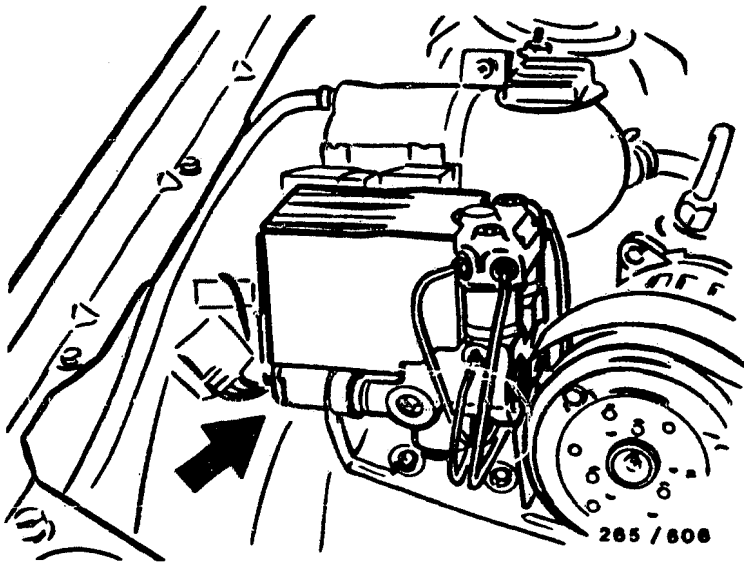
Program-selector-switch position 3

Under test (measurement at the terminals)	Additional operation	Test specification (reading)	Possible causes of trouble
Motor relay, pump motor in hydraulic modulator (term.14 and term.28)	Ignition on, press button 2 contin- uously (top picture)	LED 1 lights up, pump motor runs. After releasing button, LED con- tinues to light due to run-on of motor (top picture).	<ul style="list-style-type: none">* Motor relay defective* Test ground connection and positive terminal of pump motor* Test following leads: From controller term. 14 and term. 28 to hydraulic modulator term. 9 or term. 11. Positive leads to hydraulic modulator term. 10 and term. 12.* Pump motor or hydraulic modulator defective.



Program-selector-switch position 4 does not apply.

Arrow = Hydraulic modulator



RAPID DIAGNOSIS CHART (CONTINUED)

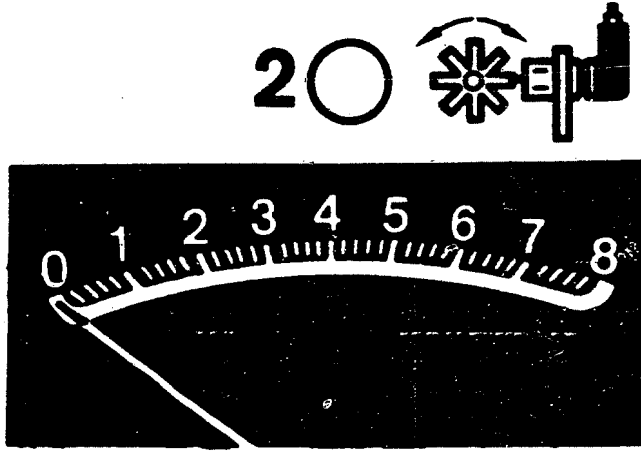
Program-selector-switch position 5 (3-channel hydraulic modulator)

Under test (measurement at the terminals)	Additional operation	Test specification (reading)	Possible causes of trouble
Valve relay operation (term. 27)	Ignition on	LED 3 (upper illustration) lights up	* Valve relay (winding) or leads defective
Solenoid-operated valves in hydraulic modulator for operation and and mix-up. NOTE: Check each wheel separately in turn. Keep to operating sequence.	Chock up vehicle. Ignition on. The wheel being tested must be freely turnable by hand. Set switch 1 for wheel selection to wheel to be tested (center illustration).		<ul style="list-style-type: none"> * Repeat test with engine running * Valve relay (make contact) defective * Break in lead from valve relay term. 87 to B+ * Brake leads at hydraulic modulator mixed up
Operation, pressure holding	1. Constantly press push-but. P = (upper illustration)	LED P= (upper illustration) lights up)	* Current value not obtained (LED P arrow or P= goes out; upper illustration): battery insufficiently charged. Repeat check with engine running.
	2. Constantly press brake pedal	Wheel turnable by hand	
	3. Release push-button P = (upper illustration)	LED P= goes out (upper illustration) Wheel locks	
Operation, pressure reduction	4. Press push-button P arrow (upper illustration)	LED P arrow (upper illustration) lights up, wheel turnable by hand	<ul style="list-style-type: none"> * Solenoid-operated valves correctly connected electrically? Wheel, front left: term. 2 Wheel, front right: term. 35 Wheel, rear left: term. — Wheel, rear right: term. — Rear axle: term. 18 * Hydraulic modulator defective
	5. Release push-button P arrow (upper illustration)	LED P arrow (upper illustration) goes out, wheel locks	
	6. Release brake pedal		

RAPID DIAGNOSIS CHART (CONTINUED)
Program-selector-switch setting 6 (3 wheel-speed sensors)

Testing of (measurement at terminals)	Additional operation	Test specifi- cation (indication)	Possible causes of trouble (see coordinates)
<p>Wheel-speed sensor for proper func- tioning and mix-up</p> <p>NOTE: Perform test con- secutively for each individual wheel.</p> <p>Wheel, front left: term.4 and term.6</p> <p>Wheel, front right: term 21 and term 23</p> <p>Rear axle: term.7 and term.9</p>	<p>Jack up vehicle. Ignition on.</p> <p>It must be possible to turn the wheel to be tested freely by hand.</p> <p>When testing driven axle, the wheel not tested must be held.</p> <p>Set switch for wheel selection to wheel to be tested (bottom picture)</p> <p>Turn wheel by hand until LED 2 above instrument lights up without flickering.</p> <p>(Speed approx. 1 revolution per second). Then read off indication on instrument: (top picture)</p>	<p>1.Smallest reading greater than 1,6 scale divisions Test specifi- cation is not obtained: If applicable, detach control units for ETC and signal conversion and repeat test.</p> <p>2.Permissible fluctuation band max. 25 % from highest value indicated.</p>	<p>* Wheel-speed-sensor lead mixed up</p> <p>* Open-circuit in wheel- speed-sensor lead</p> <p>* Wheel-speed sensor defective Winding resistance Front axle: 0,6...1,6 k Ω Rear axle: 0,6...1,6 k Ω</p> <p>* Air gap between wheel- speed sensor and ring gear too large</p> <p>* Ring gear defective (e.g. corroded, dirty) or loose.</p> <p>* Ring gear with wrong number of teeth fitted Front axle: 96 or 48 teeth Rear axle: 96 or 48 teeth</p> <p>* Wheel-bearing play excessive</p> <p>* Indication given, LED2 does not light up: loose contact in wheel- speed-sensor lead.</p>

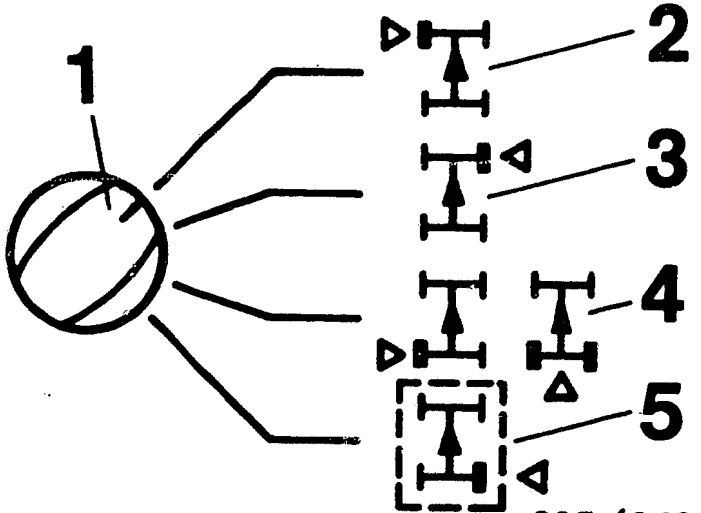
A test drive is to be performed as a final step. The warning lamp must go out when the engine is running. Drive at at least 30 km/h. The warning lamp must not light up again when doing so.



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TEST SPECIFICATIONS

Wheel-speed sensor

* Winding resistance at ambient temperature (-10°C...+120°C) for front wheels:	600...1600 Ω
rear axle:	600...1600 Ω

Hydraulic-modulator solenoid valves

* Winding resistance at ambient temperature (-10°C...+120°C):	0,7...1,7 Ω
---	--------------------

Air gap (not adjustable) between wheel-speed sensor and ring gear

* at front wheels:	0,8 \pm 0,5 mm
* at rear axle:	0,8 \pm 0,5 mm

Tightening torque for

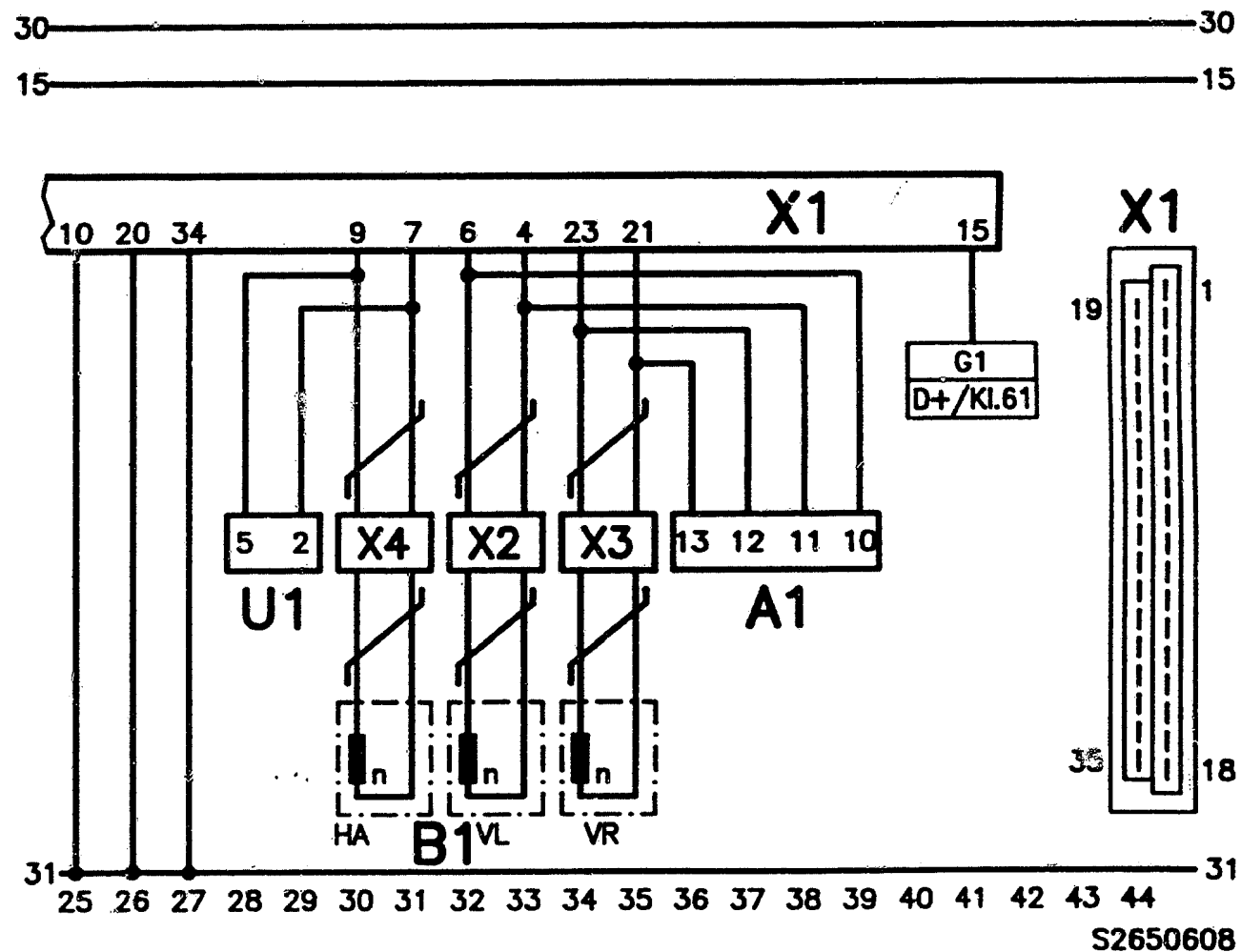
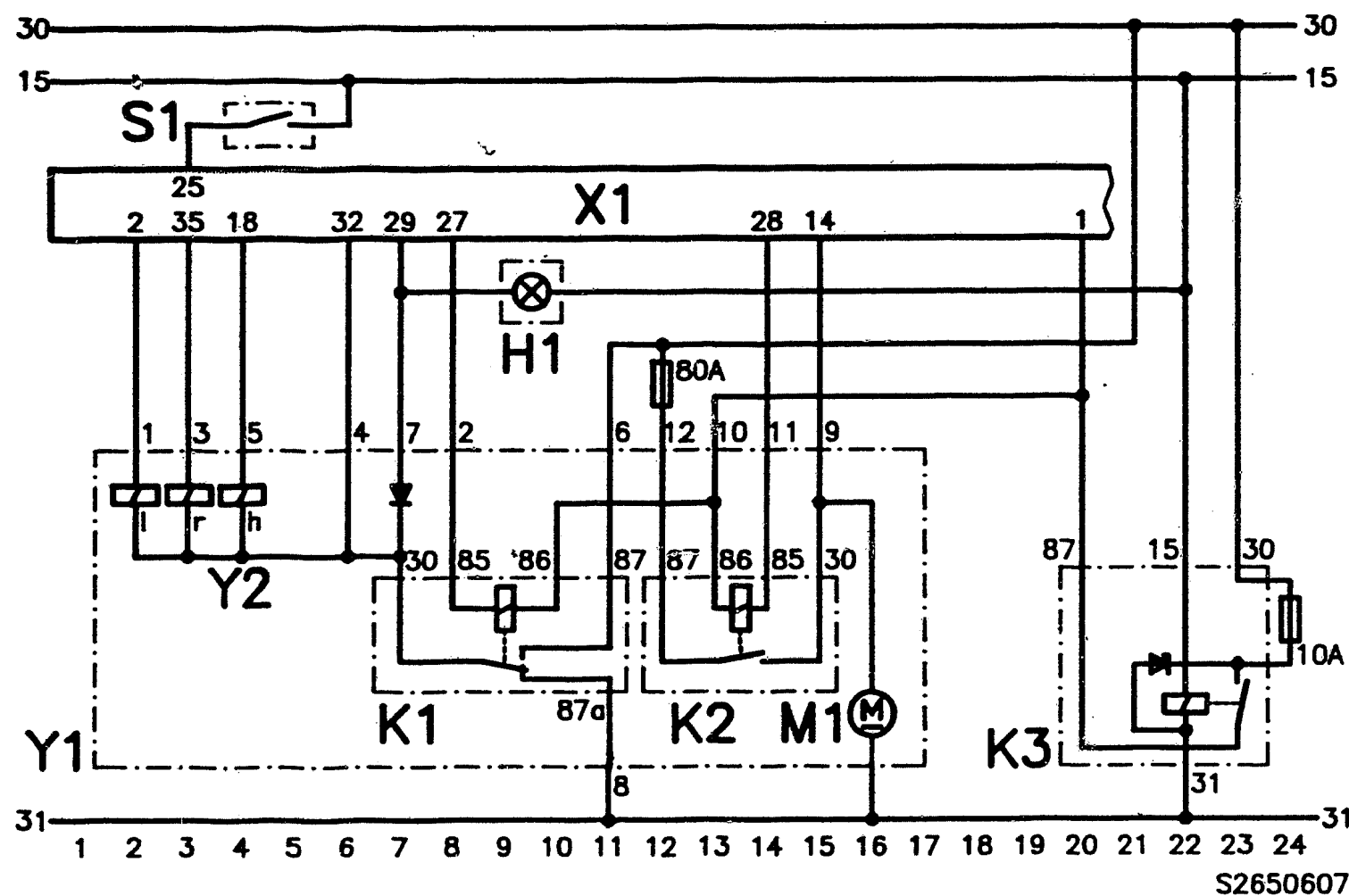
* Fastening screws of wheel-speed sensors:	> 8 Nm
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* Brake-line connections at hydraulic modulator:	12...16 Nm
--	------------

Number of teeth of wheel-speed-sensor ring gears

* at front wheels up to 8.88:	96 teeth
up to 9.88:	48 teeth
* at rear axle up to 8.88:	96 teeth
up to 9.88:	48 teeth

For production reasons:
continued on the following
coordinate.

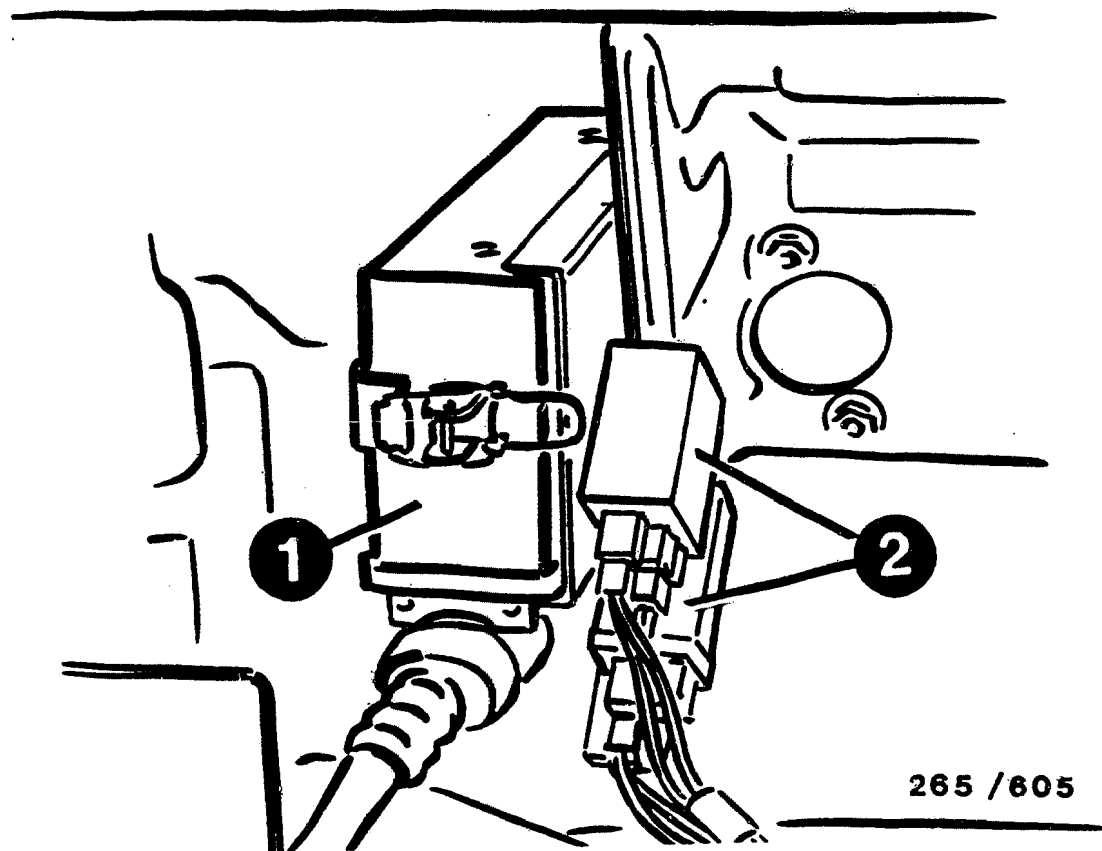


ELECTRICAL TERMINAL DIAGRAM

A1 = ETC control unit
(electronic traction control),
if applicable
B1 = Wheel-speed sensor
G1 = to alternator
H1 = ABS warning lamp
K1 = Valve relay
K2 = Motor relay
K3 = Over-voltage protec-
tion relay

M1 = Return-pump motor
S1 = Stop-lamp switch
U1 = Signal converter for speedometer;
not as of model year 89,
replaced by direct
connection to speedometer
X1 = Controller plug (35-pole)
X2...X4 = Wheel-speed-sensor plugs
Y1 = Hydraulic modulator
Y2 = Solenoid valves

HA = h = Rear axle
VL = l = Front left
VR = r = Front right

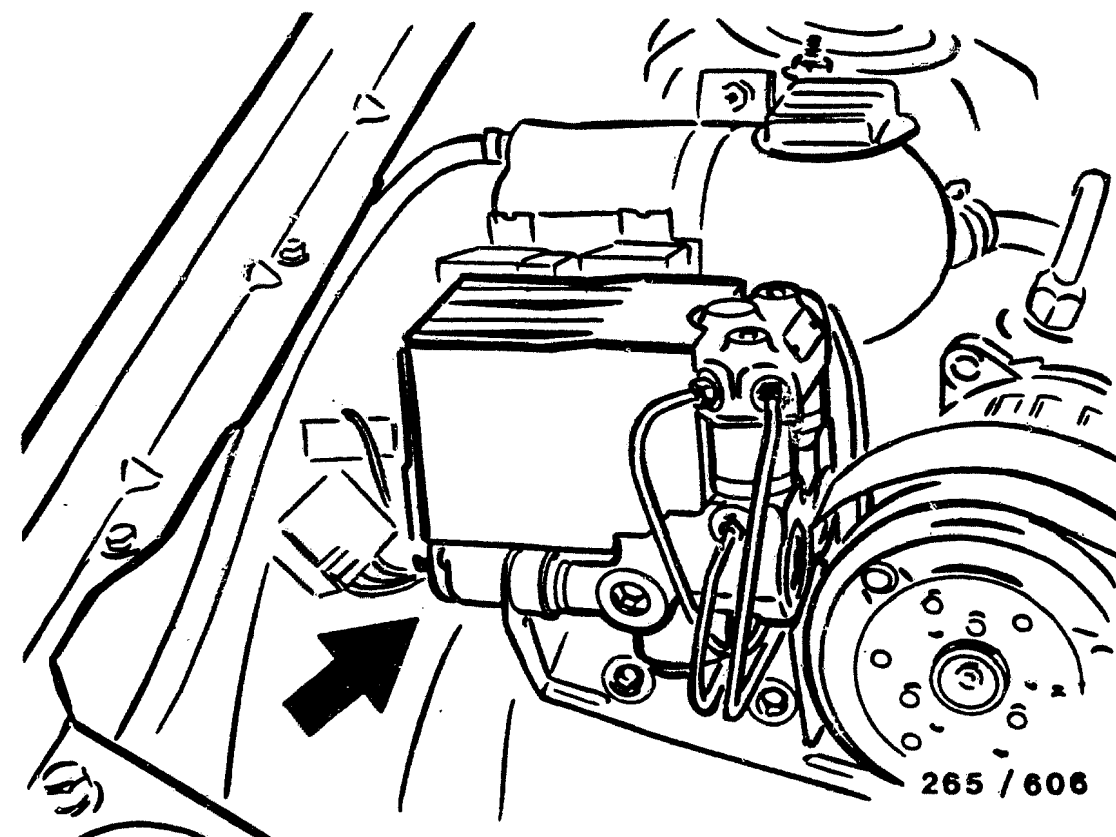


- 1 = ABS-controller
2 = Over-voltage protection relay
and signal converter

INSTALLATION POSITION OF COMPONENTS

The installation locations always refer to the direction of travel.

- * Controller:
On LHD vehicles on left beneath instrument panel next to pedal support; on RHD vehicles in right-hand footwell beneath instrument panel.
- * Over-voltage protection relay:
Beneath instrument panel at controller
- * ABS warning lamp:
in instrument panel.



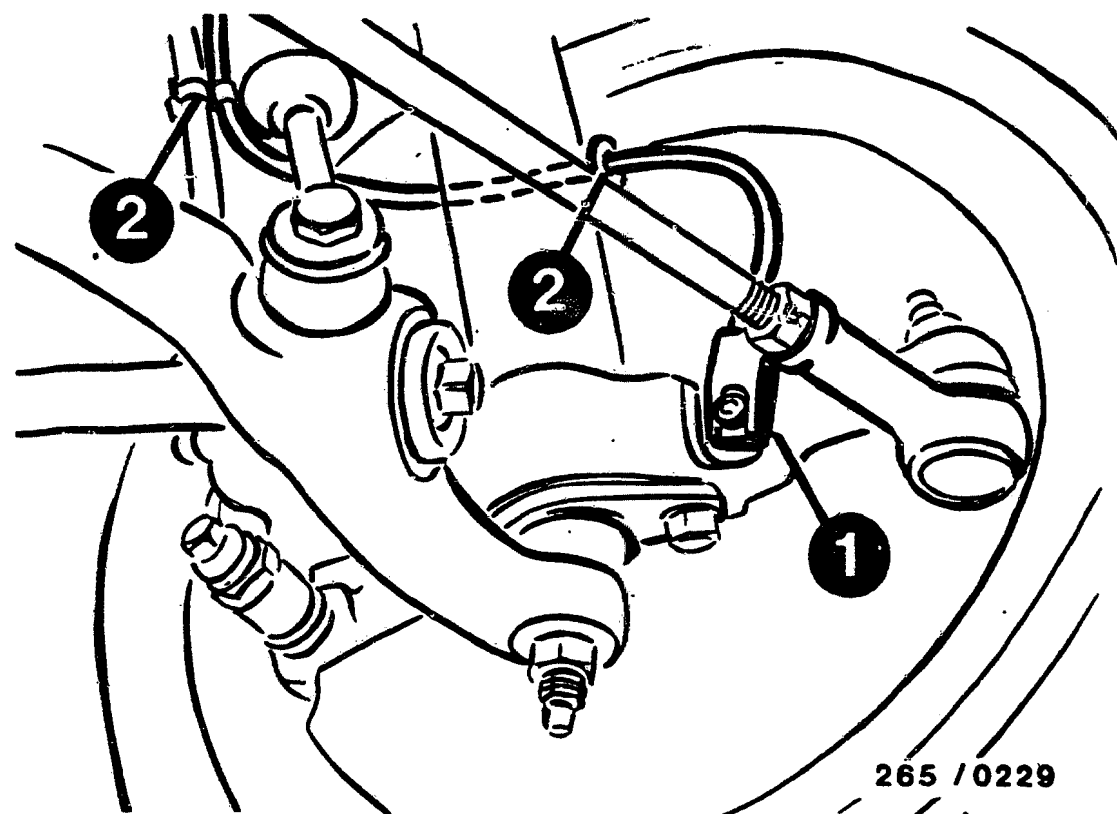
Arrow = Hydraulic modulator

INSTALLATION POSITION OF COMPONENTS (continued)

- * Hydraulic modulator:
In engine compartment on left-hand or right-hand wheel arch depending on engine version.

The hydraulic modulator is not to be repaired, but rather only replaced as a complete assembly.
Exception: Relay change.

Pay attention to proper assignment of brake-line connections.
- * Stop-lamp switch:
Beneath brake-pedal lever.
- * ABS ground terminal:
At right-hand or left-hand door hinge pillar.



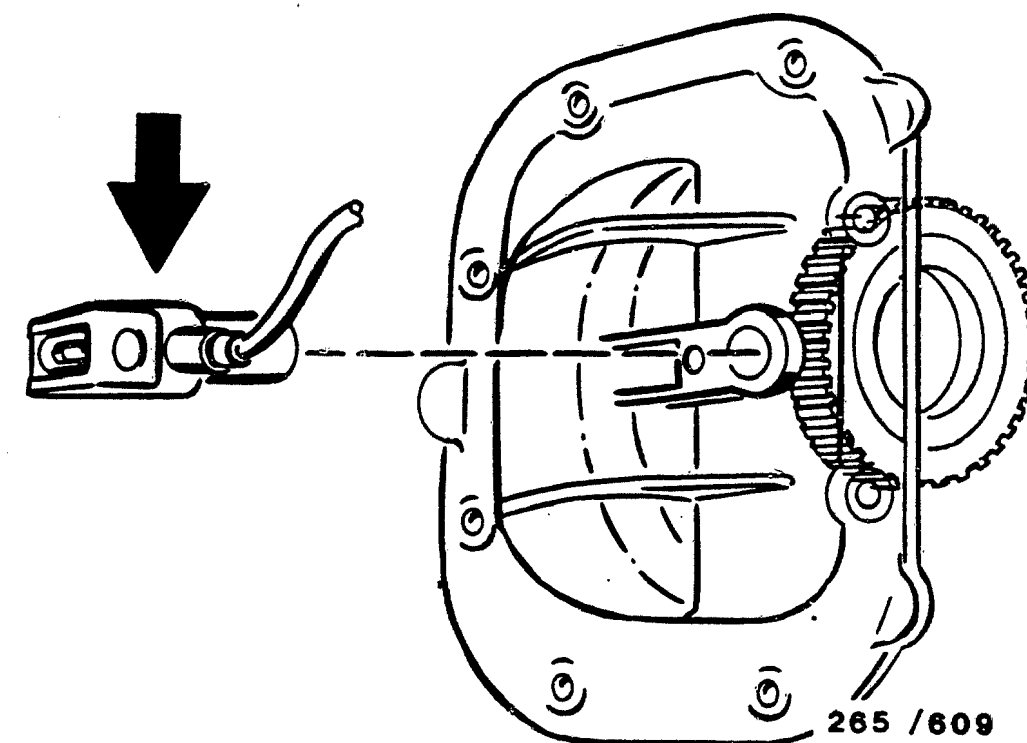
1 = Wheel-speed sensor, front

INSTALLATION POSITION OF COMPONENTS (continued)

- * Wheel-speed sensor, front axle:
One each on left and right in steering knuckles.

As of 9.88 change in number of teeth to 48 (previously 96).

Wheel-speed-sensor plug connections:
In engine compartment on left and right at spring-strut domes.



Arrow = Wheel-speed sensor, rear

INSTALLATION POSITION OF COMPONENTS (continued)

- * Wheel-speed sensor, rear axle:
Only one in final-drive housing.
Note: Do not mix up with wheel-speed sensor for ETC (electronic traction control)!

Sensor fitted without shims.
No need to adjust air gap.
As of 9.88 new sensor with direct plug connection and conversion of number of teeth to 48 (previously 96).

Wheel-speed-sensor plug connections:
In trunk.

BOSCH system : ABS
Vehicle make : BMW
Basic microcard : KFZ-00..

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Installation position of components, notes on removal and installation.....	23

SPECIAL FEATURES

This microcard contains the trouble-shooting instructions for the following models valid at the time of printing:

BMW 325 iX, (four-wheel drive)
11.1987 -> 01.1987

- * ABS with 4 wheel-speed sensors and 3 hydraulic channels.
- * Acceleration sensor (a_L)
- * Signal from clutch switch
- * Idle-speed increase

STRUCTURE, USAGE

These brief instructions encompass essentially vehicle-specific special features and test specifications (set values).

For a detailed description of trouble-shooting, see the basic instructions.

ATTENTION :
The set values, terminal assignments and special features of these vehicle-specific brief instructions are always binding.

SAFETY AND PRECAUTIONARY MEASURES

- * For reasons of safety, the hydraulic modulator must not be repaired, but be exchanged only as a complete unit.
Exception: relays.
- * Do not loosen any screws on the hydraulic modulator!
There would then be danger of fatal accident caused by failure of the brakes.
- * Caution when handling brake fluid.
Poisonous!
- * Only a limited brake test is permitted; no power-output test is permitted.

For further information, see brief instructions.

TEST REQUIREMENTS FOR TESTING WITH ABS2 LED TESTER

- * Regulatory tire size fitted?
- * Check for firm seating of ground of return-supply pump.
- * Check for firm seating and corrosion of ground of overvoltage-protection relay term. 31.
- * Check for firm seating of ground strap between engine block and vehicle frame.
- * Check for leaks in hydraulic connections at hydraulic modulator and sealing points (visual examination).
- * If the ABS warning lamp lights up intermittently when driving (e.g. after switching on loads) and goes out again by itself, check the battery and power supply (alternator, regulator and voltage drops).
- * If the ABS warning lamp lights up constantly and does not go out, check the following points:
 - Controller plug sitting correctly on controller and latched?
 - All plug contacts O.K.?
 - Spring contacts latched?
 - Check installation position for correct seating of seal ring in controller plug, rounded side downward.

- Check wheel-speed-sensor leads for correct assignment at controller plug:

Wheel-speed sensors:

front left to term. 22 and term. 4.
front right to term. 11 and term. 21.
rear left to term. 8 and term. 9.
rear right to term. 24 and term. 26.
rear axle to term. - and term. -.

- V-belt snapped?
(Alternator provides no voltage, charge-indicator lamp and ABS warning lamp light up).
- * Connect ABS 2 LED tester to ABS wiring harness.
- Disconnect and connect controller only with ignition switched off.
- For testing, switch on ignition in all program-selector-switch positions (tester operates with current supply from vehicle battery).
- Observe LED (green) for current supply in all program-selector-switch positions.

C A U T I O N !

Do not drive with tester connected!

The brake system must be bled of air before the ABS test. Do not activate the ABS tester while the system is being bled.

Repeat the complete test program after any repairs are carried out.

The Antiskid System is a vehicle safety system.

Work on the system demands detailed knowledge of the system.

The conventional brake system must be O.K.

General information for trouble-shooting:

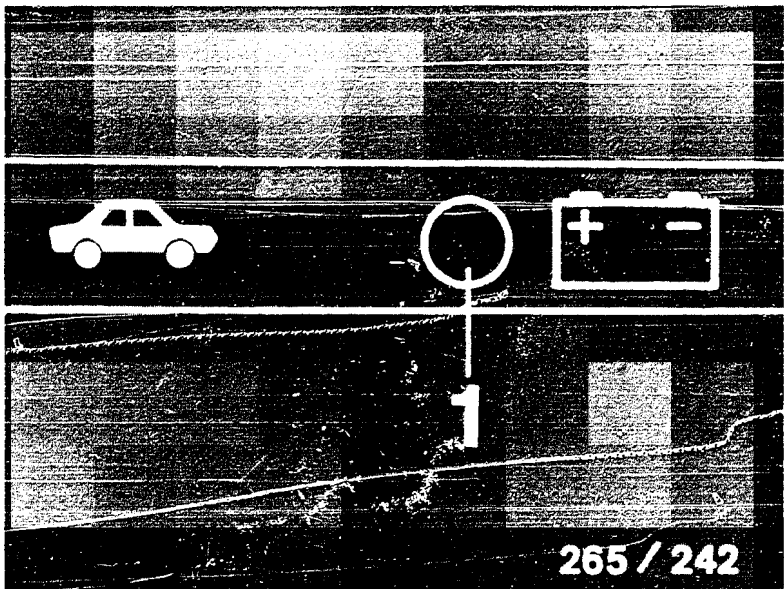
Check all leads for short circuit to ground and contact with positive leads and watch out for worn cable insulation and pinched leads.

RAPID DIAGNOSIS CHART

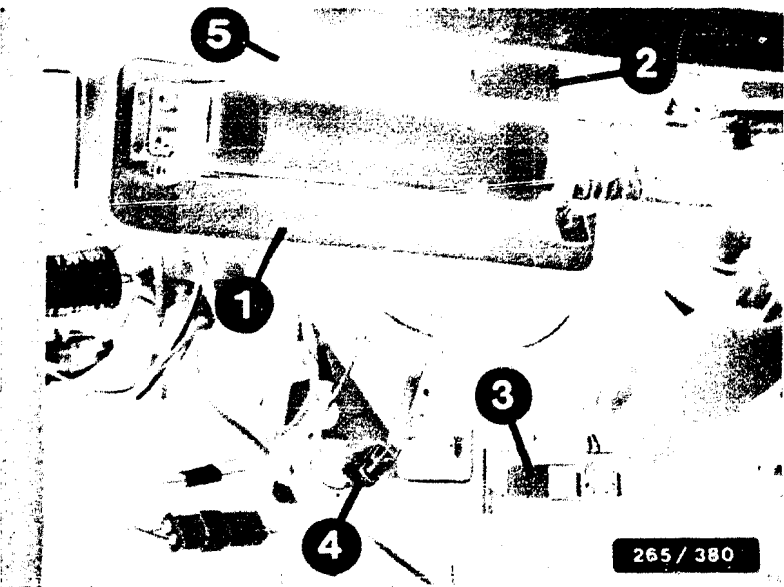
Do not drive with tester connected. Are all test conditions met?

Program-switch positions 1 to 6

Testing of (measurement at terminals)	Additional operation	Test specifi- cation (reading)	Possible causes of faults
Power supply (term.1 und term.20)	Ignition on	LED 1 (top picture) continuously lit	<ul style="list-style-type: none">*Battery insufficiently charged*High voltage drops*Overvoltage-protection relay defective*Check lead to ignition and starting switch, term. 15



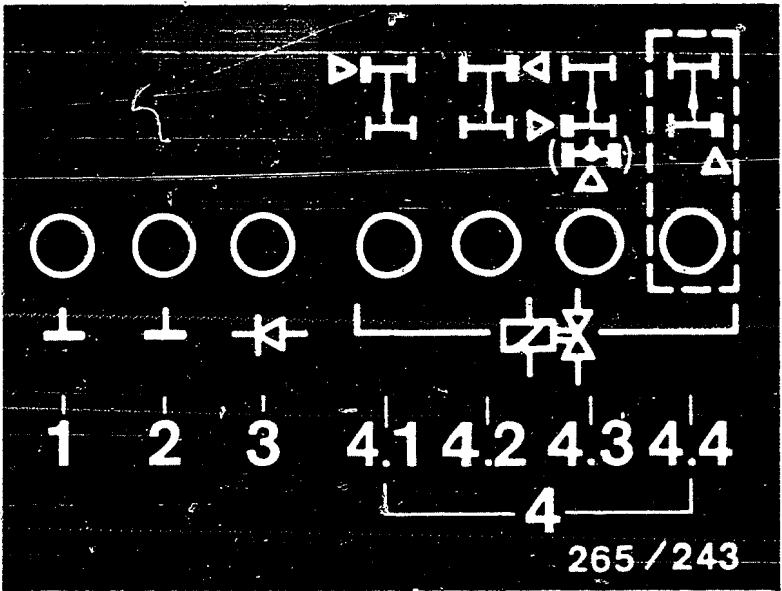
- 1 = Controller
- 2 = Overvoltage-protection relay
- 3 = Stop-lamp switch
- 4 = Clutch switch
- 5 = Ground terminal



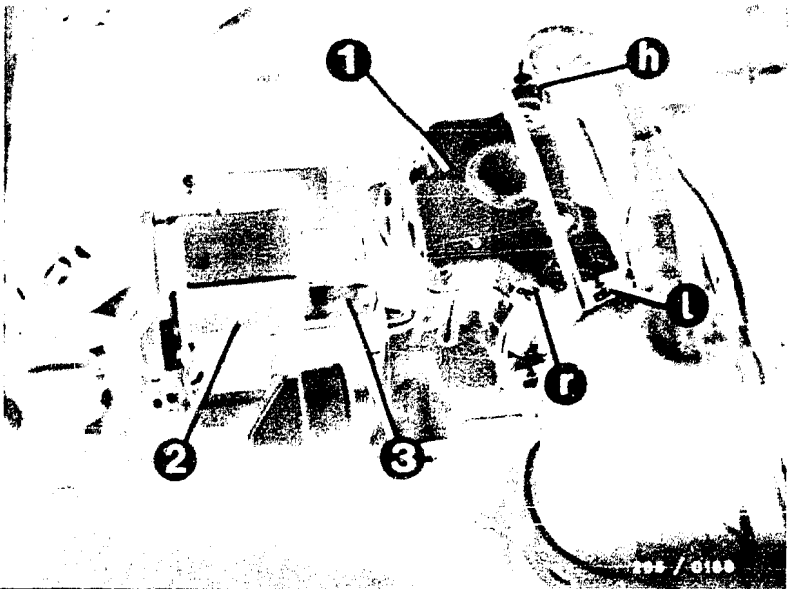
RAPID DIAGNOSIS CHART (CONTINUED)

Program-switch position 1 (3-channel hydraulic modulator)

Testing of (measurement at terminals)	Addition- al operation	Test specifi- cation (reading)	Possible causes of faults
Ground connection (term.10, term.34) Diode for warning lamp (term.29, term.32) Solenoid-operated valve internal res. (term.2, term.18, term.—, term.35) Off-position and ground connection of relay ABS warning lamp	Ignition on	6 LED (1 to 4.3) simultaneously brightly lit (top picture) ABS warning lamp in vehicle must light up	<ul style="list-style-type: none">* LED 1 and/or 2 (top picture) not lit: Check ground terminals for open circuit.* LED 3 (top picture) not lit: Diode defective, check ground connection of valve relay.* One or more LEDs 4 not lit: Check corresponding plug-in connection for solenoid- operated valve and leads.Solenoid-operated valve internal resistance 0,7...1,7 Ω* All LEDs 4 and LEDs 3 not lit: Check ground connection of valve relay, valve relay defective.* Dimmer lighting-up of an LED means contact resistance in the corresponding circuit.* ABS warning lamp not lit: Warning lamp defective. Note: all other 6 LEDs lit.



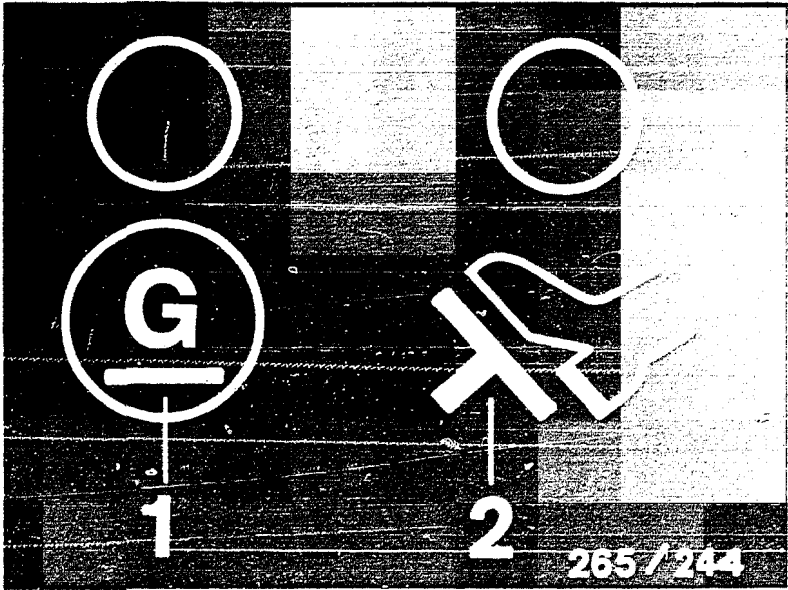
1 = Hydraulic modulator
2 = Motor relay
3 = Valve relay



RAPID DIAGNOSIS CHART (CONTINUED)

Program-selector-switch position 2

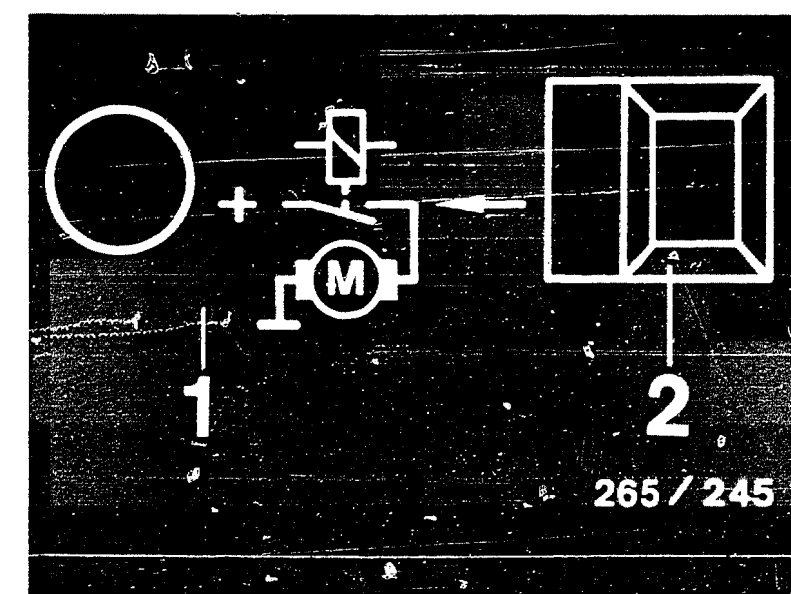
Under test (Measurement at the terminals)	Additional operation	Test specifi- cation (reading)	Possible causes of trouble
Alternator voltage from term. 61/D+ (term. 15)	Ignition on	LED 1 (top picture) lit.	* In some cases, LED does not go out until after burst of throttle (test is O.K. in this case).
	Start engine	LED 1 (top picture) goes out when engine running	* Test lead and signal from alternator term. 61 * Alternator defective.
Stop-lamp switch (term.25)	Ignition on	LED 2 (top picture) lit	* Stop-lamp switch defective. * Check lead to stop-lamp switch.
	Press brake pedal	LED 2 (top picture) goes out	* Lead incorrectly connected to to stop-lamp switch.



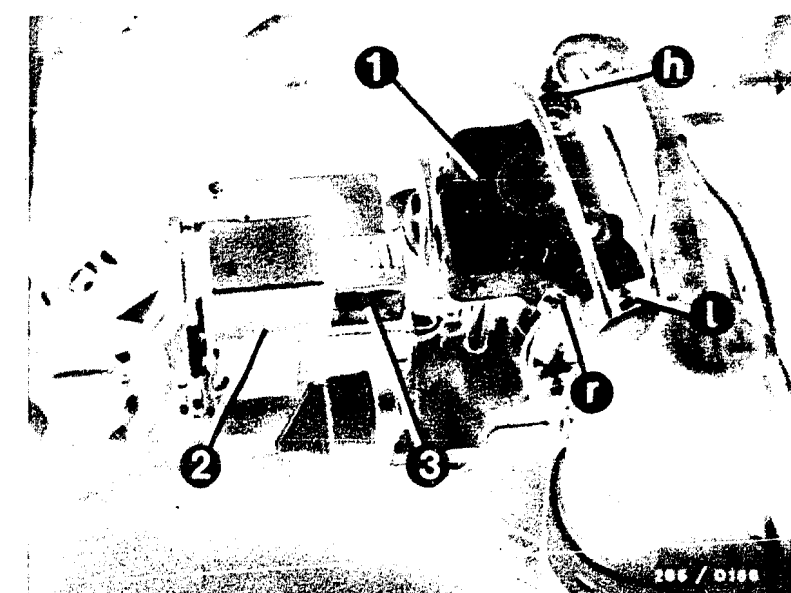
RAPID DIAGNOSIS CHART (CONTINUED)

Program-switch position 3

Testing of (measurement at terminals)	Additional operation	Test specifi- cations (reading)	Possible causes of faults
Motor relay, Pump motor in hydraulic modulator (term.28 and term.14)	Ignition on, Press button 2 continuously (top picture)	LED 1 lit, pump motor running. After button is released, LED continues to light due to running-on of motor (top picture).	<ul style="list-style-type: none"> * Motor relay defective * Check ground connection and positive terminal of hydraulic modulator * Check leads from controller term.14 and term.28 to hydraulic modulator term.9 and term. 11. * Pump motor defective



1 = Hydraulic modulator
2 = Motor relay
3 = Valve relay



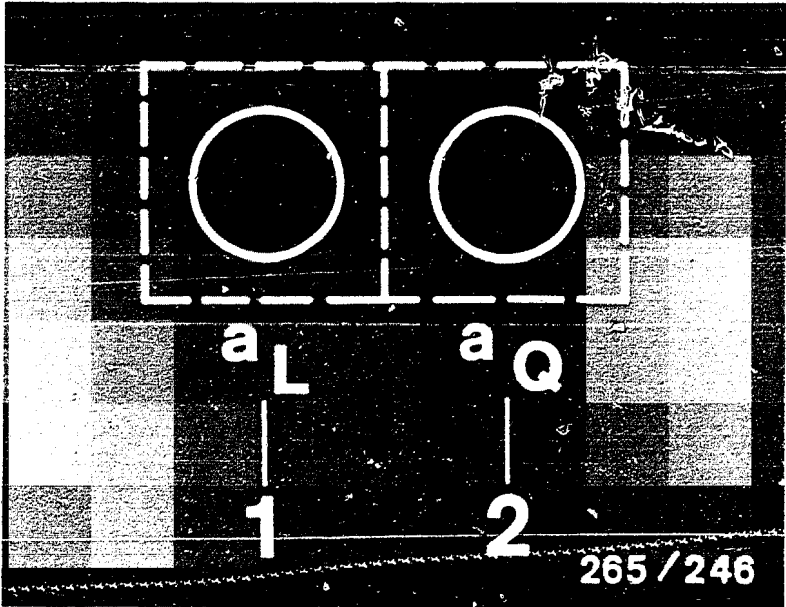
RAPID DIAGNOSIS CHART (CONTINUED)

Program-switch position 3

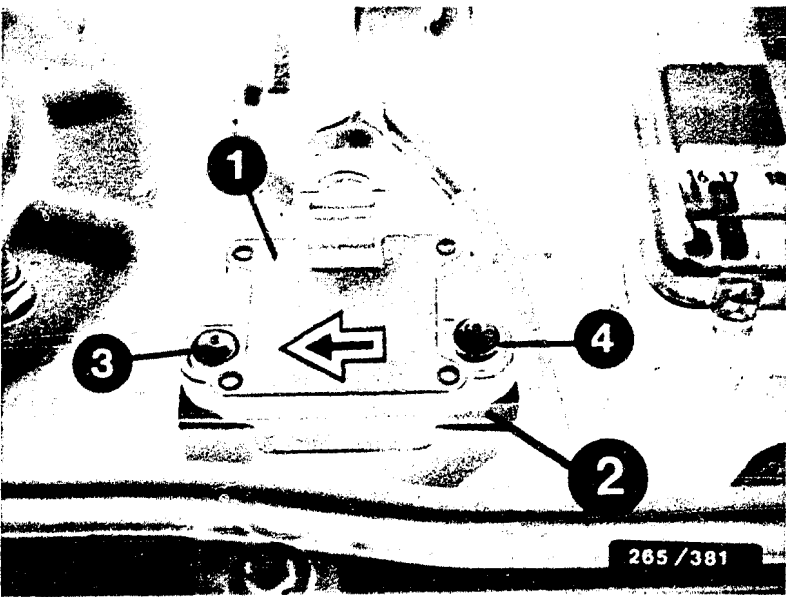
RAPID DIAGNOSIS CHART (CONTINUED)

Program-selector-switch position 4

Under test (measurement at the terminals)	Addition- al operation	Test specification (reading)	Possible causes of trouble
Acceleration sensor a _L (term.16)	Ignition on	LED a _L lights up	<ul style="list-style-type: none">* Check acceleration sensor: resistance value: <100 Ω Exchange sensor: drill out shear-head screw. Adjust sensor with special tool Pay attention to installation position. Use new shear-head screws.* Check lead from acceleration sensor to ABS controller term.16.* Check lead from controller term.1 to acceleration sensor.

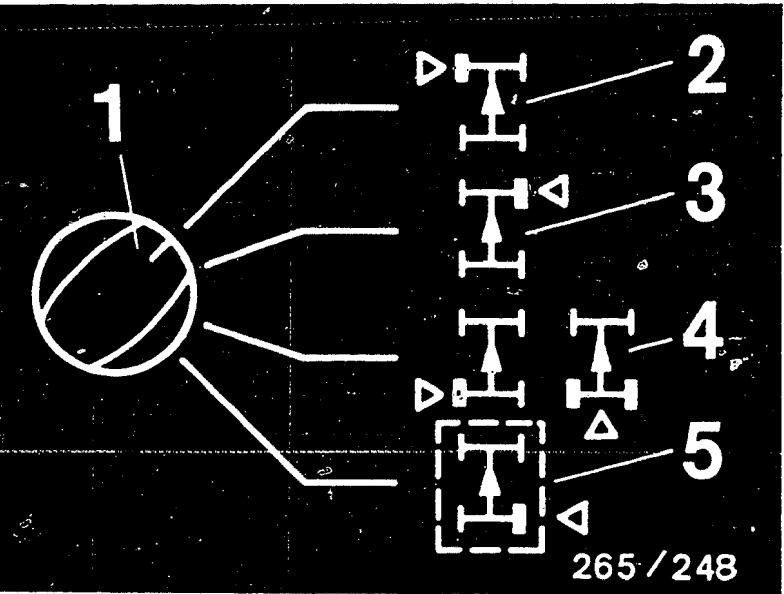
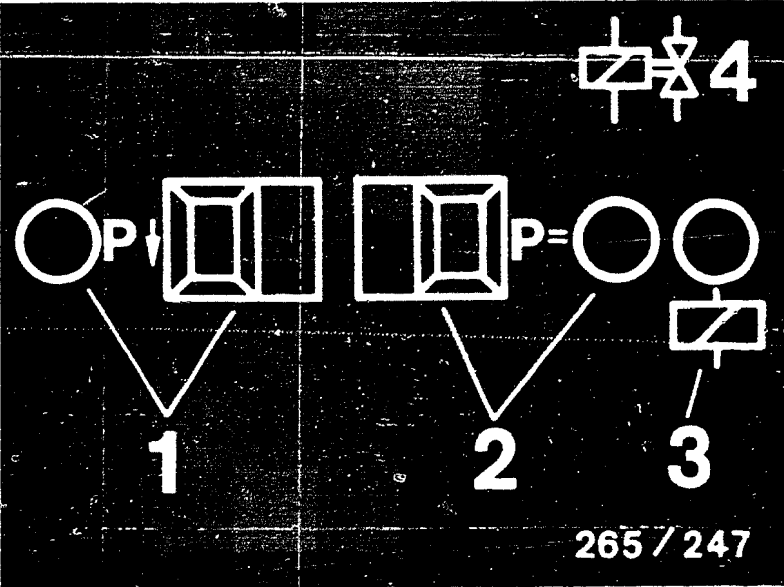


- 1 = Acceleration sensor
 - 2 = Chock
 - 3 = Shear-head screw, front
 - 4 = Shear-head screw, rear
- Arrow = Forward direction of travel



RAPID DIAGNOSIS CHART (CONTINUED)
Program-selector-switch position 5 (3-channel hydraulic modulator)

Under test (measurement at the terminals)	Additional operation	Test specification (reading)	Possible causes of trouble
Valve-relay opera- tion (term.27)	Ignition on	LED 3 (upper illustration) lights up	*Valve relay (winding) or leads defective
Solenoid-operated valve in hydraulic modulator for operation and mix-up. NOTE: Check each wheel separately in turn. Keep to operating sequence!	Choke up vehicle. Ignition on. The wheel being tested must be freely turnable by hand. Set switch 1 for wheel selection to wheel to be tested. For the rear axle, set to position 4 (lower illustration).		* Repeat test with engine running * Valve relay (make contact) defective * Break in line from valve relay term. 87 to batt. +ve * Brake leads at hydraulic modulator mixed up
Operation pressure holding	1. Constantly press push- button P= (lower illus.)	LED P= (lower illus.) lights up	* Current value not obtained (LED P arrow or P= goes out; upper illustration); battery insufficiently charged. Repeat check with engine running.
	2. Constantly depress brake pedal	Wheel turnable by hand	
	3. Release push- button P= (upper illustration)	LED P= goes out (upper illus.) Wheel locks	
Operation pressure reduction	4. Press push- button P arrow (upper illustration)	LED P arrow (upper illustration) lights up, wheel turnable by hand	* Solenoid-op. valves correct- ly connected electrically? Wheel, front left: term.2 Wheel, front right: term.35 Wheel, rear left: term.— Wheel, rear right: term.— Rear axle: term.18 * Hydraulic modulator defective
	5. Release push- button P arrow (upper illustration)	LED P arrow (upper illus- tration) goes out, wheel locks	
	6. Release brake pedal		

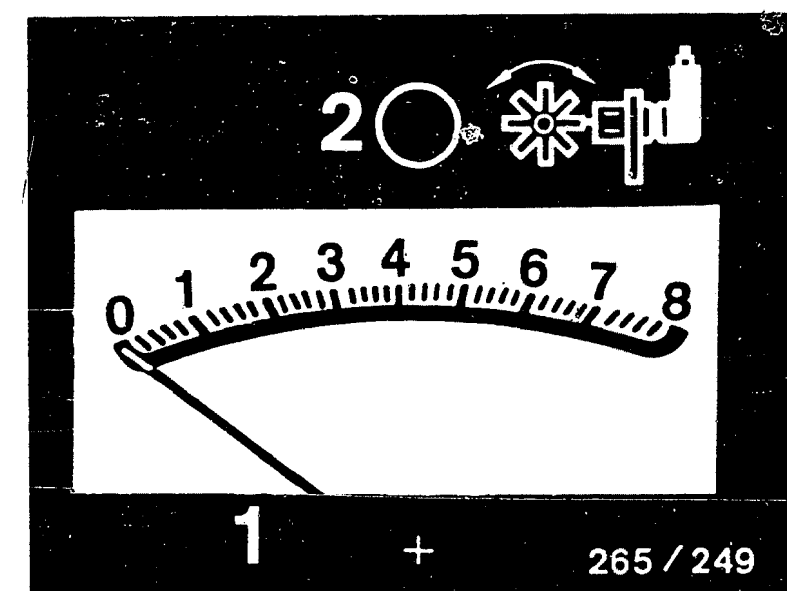
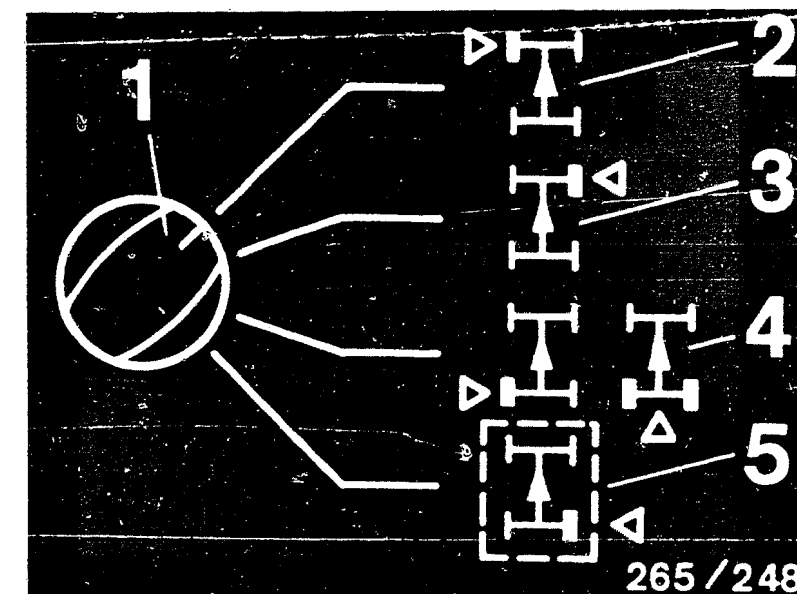


RAPID DIAGNOSIS CHART (CONTINUED)

Program-selector-switch position 6 (4 wheel-speed sensors)

Under test (measurement at the terminals)	Additional operation	Test specification (reading)	Possible causes of trouble
<p>Wheel-speed sensor for operation and mix-up</p> <p>NOTE: Check each wheel separately in turn.</p> <p>Wheel, front left: term.4 and term.0,6...1,6 Wheel, front right: term.11 and term.21 Wheel, rear left: term.8 and term.9 Wheel, rear right: term.24 and term.26)</p>	<p>Chock up vehicle. Ignition on.</p> <p>The wheel being tested must be freely turnable by hand.</p> <p>When testing the driven axle, the wheel not being tested must be locked.</p> <p>Set switch for wheel selection to wheel to be tested (lower illustration)</p> <p>Turn wheel by hand until LED 2 above instrument lights up without flickering. (Wheel speed approx. 1 revolution per second). Afterwards, read off indication at instrument: (upper illustration)</p>	<p>1.Smallest reading larger 1,6 divisions</p> <p>2.Permissible fluctu- ation max. 25 % of largest reading.</p>	<p>*Wheel-speed-sensor lead mixed up</p> <p>*Break in wheel-speed- sensor lead</p> <p>*Wheel-speed sensor defective Winding resistance Front axle: 0,6...1,6 k Ω Rear axle: 22 k Ω</p> <p>*Air gap between wheel-speed sensor and ring gear too wide</p> <p>*Ring gear defective or loose</p> <p>*Ring gear with incorrect number of teeth installed Front axle: 48 teeth Rear axle: 48 teeth</p> <p>*Wheel-bearing clearance too large</p> <p>*Reading appears, LED 2 does not light up: loose contact in wheel- speed-sensor lead.</p>

Continue test with next coordinate.



Check idle-speed increase.

1.Throttle-valve positioner:

- *Ignition off and on: Idle stop of actuator extended. If not, actuator defective.
- *Operate engine at idle speed:
Idle stop of actuator retracted.
If not, idle speed far too high. Check vacuum energization of actuator:
- *Check hoses for leaks and correct assignment.
- *Disconnect hose from throttle-valve positioner and apply vacuum to actuator with vacuum pump.
Stop must retract. If not, actuator defective. If yes, check solenoid-operated valve.
- *Adjust idle-speed increase:
Disconnect hose from actuator. With engine running, idle speed increases to 2400+ 100 min⁻¹. If not, adjust engine speed at adjusting screw on actuator.

2.Solenoid-operated valve:

- *Disconnect plug from solenoid-operated valve and apply battery voltage to valve.
With engine running, idle stop of actuator must extend and engine speed must rise.
If not, solenoid-operated valve defective.
If yes, check leads to solenoid-operated valve.
- *Ignition off. Check for open circuit and short circuit in leads from solenoid-operated valve to controller plug term.3 and to ground.

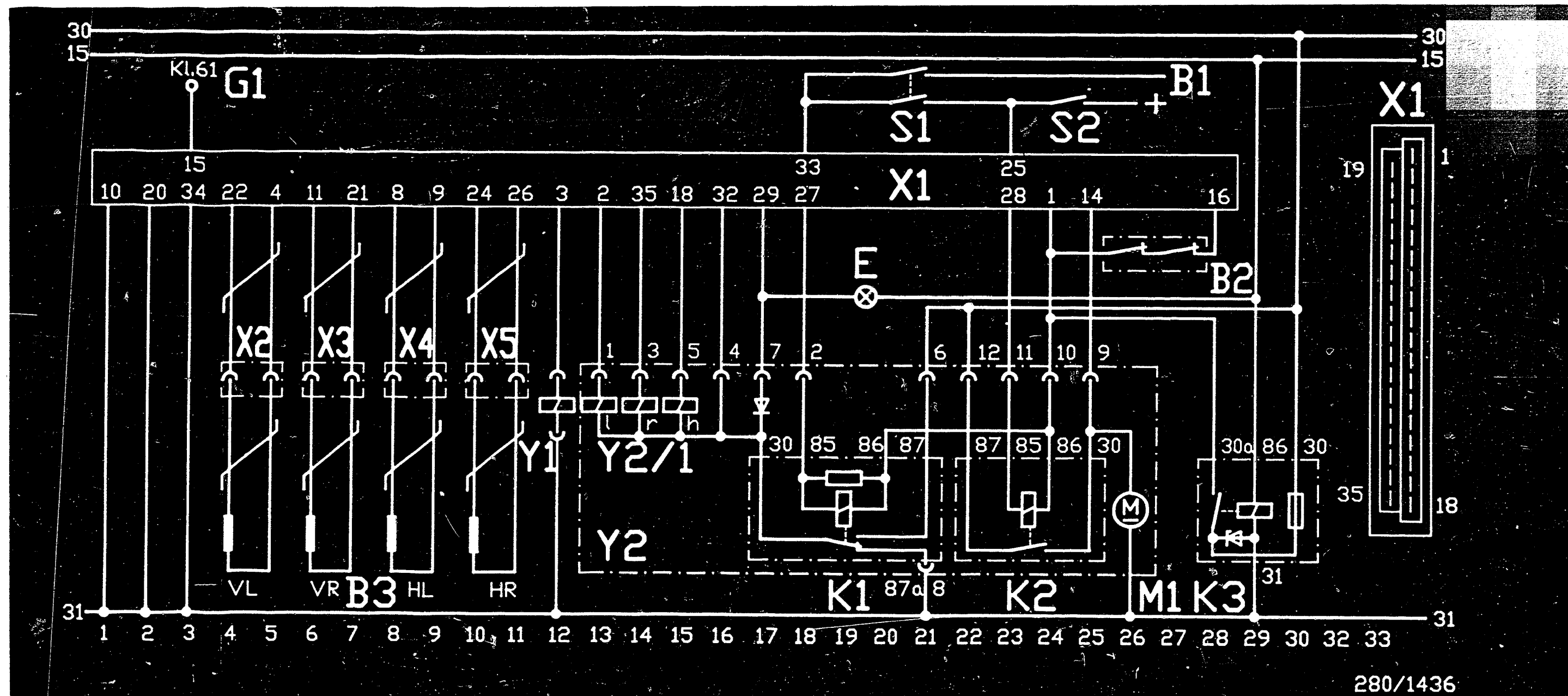
3.Clutch switch:

- *Ignition off. Disconnect controller plug.
Connect voltmeter to term.33 (+) and ground.
Ignition on and press brake pedal:
Voltage must be greater than 10 V .
Depress clutch: Voltage 0 V.
If not correct, check switch and leads;
adjust switch.

Final check: Road test for at least 20 seconds at above 30 km/h, and drive for at least 3 seconds at at least 50 km/h. Warning lamp must not come on.

TEST SPECIFICATIONS

Wheel-speed sensors	
* Winding resistance at ambient temperature (-10°C...+120°C) for	
Front axle:	600...1600 Ω
Rear axle:	600...1600 Ω
Hydraulic-modulator solenoid-operated valves	
* Winding resistance at ambient temperature (-10°C...+120°C):	0,7...1,7 Ω
Air gap:	0,8 ± 0,5 mm
Tightening torque for	
* Wheel-speed sensor fastening screws:	> 8 Nm
* Brake-line connections on hydraulic modulator:	12...16 Nm
Number of teeth	
* Front axle:	48 teeth
* Rear axle:	48 teeth
Acceleration sensor	
* Contacts closed when in horizontal position:	< 100 Ω
Solenoid-operated valve for idle-speed increase	
* Winding resistnace at ambient temperature (+15°C...+30°C):	18...45 Ω

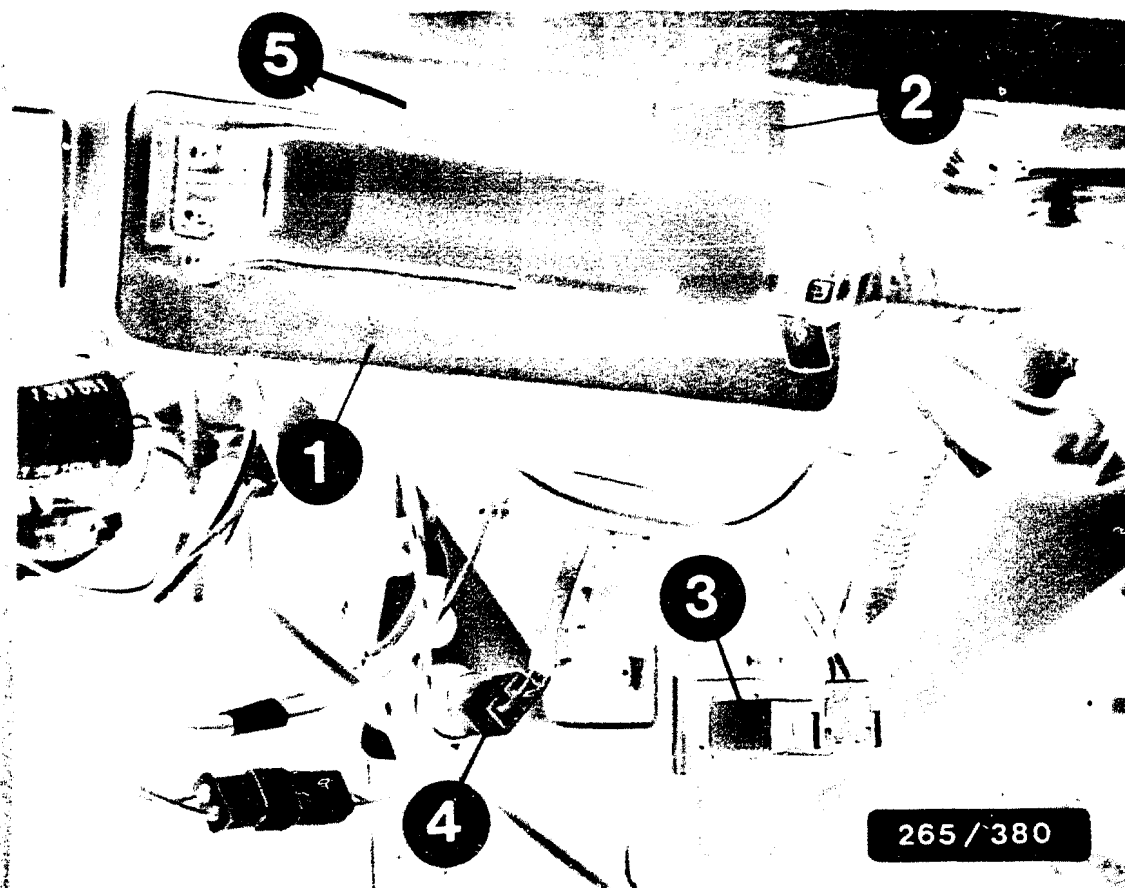


B1 = Cruise control
 B2 = Acceleration sensor
 B3 = Wheel-speed sensor
 E = ABS warning lamp
 G1 = To alternator
 K1 = Valve relay
 K2 = Motor relay
 K3 = Overvoltage-protection relay

M1 = Return-pump motor
 S1 = Clutch switch
 S2 = Stop-lamp switch
 X1 = Controller plug (35-pin)
 X2...X5 = Cable connectors
 Y1 = Solenoid-op. valve for idle increase
 Y2 = Hydraulic modulator
 Y2/1 = Solenoid-operated valves

VL = l = Front left
 VR = r = Front right
 HA = h = Rear axle
 HL = Rear left
 HR = Rear right

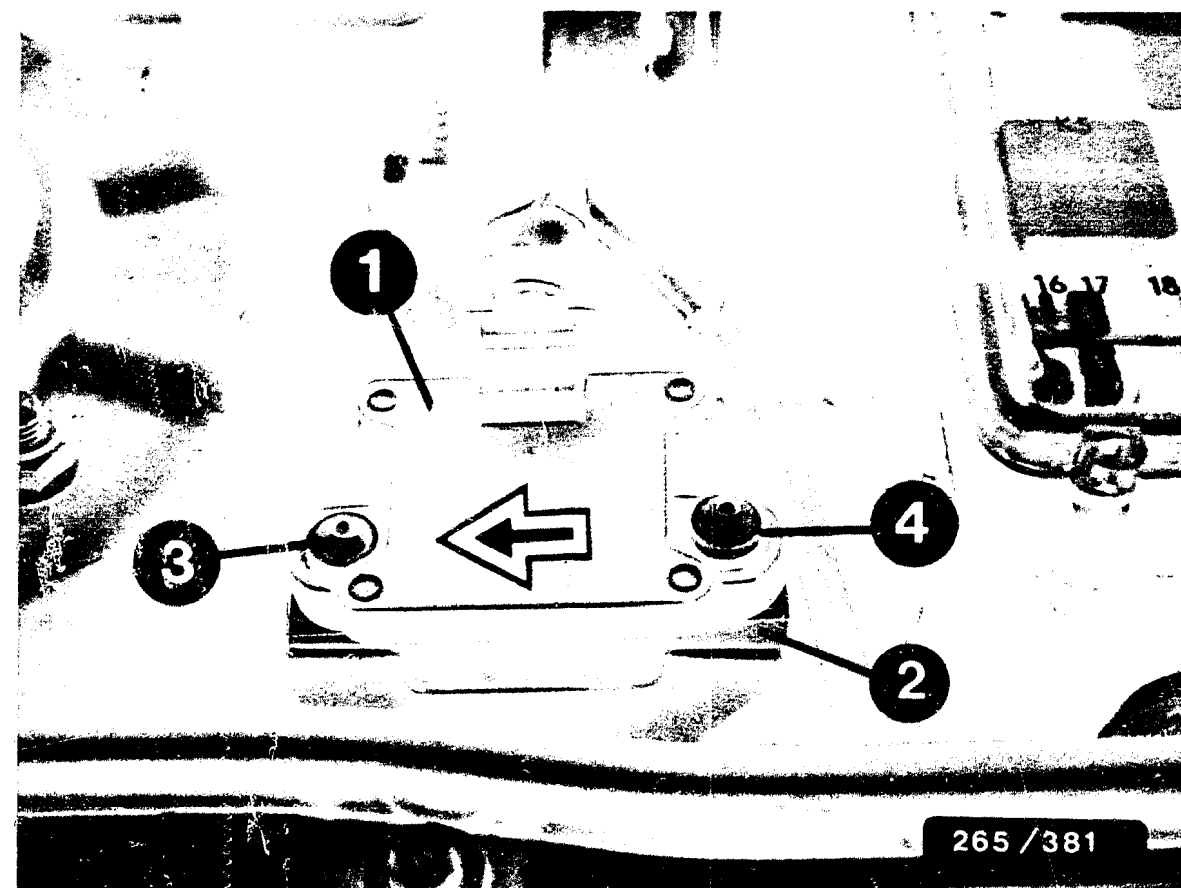
ELECTRICAL TERMINAL DIAGRAM ->1.87



INSTALLATION POSITION OF COMPONENTS

The indications "right" and "left" always refer to the forward direction of travel.

- * Controller (Item. 1):
to the left of the steering column behind the footwell panelling.
- * Overvoltage-protection relay (Item 2):
on the right above the controller.
- * Stop-lamp switch (Item. 3):
on the brake pedal.
- * Clutch switch (Item 4):
on the clutch pedal.
- * Ground terminal (Item 5) for ABS:
behind the controller.
- * ABS warning lamp: in the instrument panel.
- * Battery: in the luggage compartment on the right.



- 1 = Acceleration sensor
- 2 = Chock
- 3 = Shear-head screw, front
- 4 = Shear-head screw, rear
- Arrow = Forward direction of travel

INSTALLATION POSITION OF COMPONENTS (Continued)

Exchange accelerator sensor:
drill out shear-head screws. Adjust sensor using special tool. Pay attention to direction of installation. Use new shear-head screws.

- * Wheel-speed sensors, front axle:
left and right in the steering knuckles.
Do not mix up the left-hand and the right-hand wheel-speed sensors when installing.
- * Wheel-speed sensors, rear axle:
left and right near to the brake calipers.
- * Ground cables for pump motor and valve relay (->8.87):
in the engine compartment on the left-hand side on the bodywork.



- 1 = Solenoid-operated valve
- a = Vacuum line to intake manifold
- b = Vacuum line to actuator
- c = Vent to atmosphere
- 2 = Throttle-valve positioner
- 3 = Adjusting screw

INSTALLATION POSITION OF COMPONENTS (continued)

Adjusting the throttle-valve positioner:

Operate engine at idle speed and disconnect vacuum hose from actuator. Idle speed must increase to $2400 \pm 100 \text{ min}^{-1}$. Engine speed can be corrected with throttle-valve positioner adjusting screw.

* Hydraulic modulator:

In engine compartment behind left-hand headlamp.

The hydraulic modulator must not be repaired, but must be replaced only as a complete unit. Exception: Replacement of relays.

For production reasons:
continued on the following
coordinate.

Trouble-shooting instructions : BMW-5011

BOSCH system : ABS

Make of vehicle : BMW

Basic microcard : KFZ-00..

TABLE OF CONTENTS

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Structure, usage.....	02
Safety and precautionary measures.....	02
Test requirements.....	03
Rapid diagnosis chart.....	05
Engine-drag-torque control.....	19
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SPECIAL FEATURES

This microcard contains the trouble-shooting instructions, valid at the time of publication, for the following models:

BMW 325 iX, (all-wheel drive)
01.1987 ->

- * ABS with 4 wheel-speed sensors and 3 hydraulic channels.
- * Acceleration sensor (a_L)
- * Signal from clutch switch
- * Engine-drag-torque control

STRUCTURE, USAGE

These brief instructions encompass essentially vehicle-specific special features and test specifications (set values).

For a detailed description of trouble-shooting, see the basic instructions.

ATTENTION :
The set values, terminal assignments and special features of these vehicle-specific brief instructions are always binding.

SAFETY AND PRECAUTIONARY MEASURES

- * For reasons of safety, the hydraulic modulator must not be repaired, but be exchanged only as a complete unit.
Exception: relays.
- * Do not loosen any screws on the hydraulic modulator!
There would then be danger of fatal accident caused by failure of the brakes.
- * Caution when handling brake fluid.
Poisonous!
- * Only a limited brake test is permitted; no power-output test is permitted.

For further information, see brief instructions.

TEST REQUIREMENTS FOR TESTING WITH ABS2 LED TESTER

- * Regulatory tire size fitted?
- * Check for firm seating of ground of return-supply pump.
- * Check for firm seating and corrosion of ground of overvoltage-protection relay term. 31.
- * Check for firm seating of ground strap between engine block and vehicle frame.
- * Check for leaks in hydraulic connections at hydraulic modulator and sealing points (visual examination).
- * If the ABS warning lamp lights up intermittently when driving (e.g. after switching on loads) and goes out again by itself, check the battery and power supply (alternator, regulator and voltage drops).
- * If the ABS warning lamp lights up constantly and does not go out, check the following points:
 - Controller plug sitting correctly on controller and latched?
 - All plug contacts O.K.?
 - Spring contacts latched?
 - Check installation position for correct seating of seal ring in controller plug, rounded side downward.

- Check wheel-speed-sensor leads for correct assignment at controller plug:

Wheel-speed sensors:

front left to term. 22 and term. 4.
front right to term. 11 and term. 21.
rear left to term. 8 and term. 9.
rear right to term. 24 and term. 26.
rear axle to term. - and term. -.

- V-belt snapped?
(Alternator provides no voltage, charge-indicator lamp and ABS warning lamp light up).
- * Connect ABS 2 LED tester to ABS wiring harness.
- Disconnect and connect controller only with ignition switched off.
- For testing, switch on ignition in all program-selector-switch positions (tester operates with current supply from vehicle battery).
- Observe LED (green) for current supply in all program-selector-switch positions.

C A U T I O N !

Do not drive with tester connected!

The brake system must be bled of air before the ABS test. Do not activate the ABS tester while the system is being bled.

Repeat the complete test program after any repairs are carried out.

The Antiskid System is a vehicle safety system.

Work on the system demands detailed knowledge of the system.

The conventional brake system must be O.K.

General information for trouble-shooting:

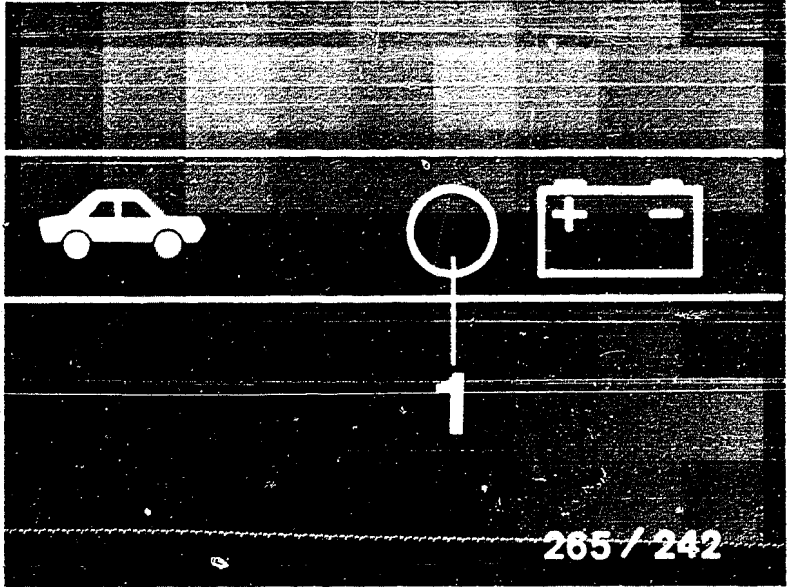
Check all leads for short circuit to ground and contact with positive leads and watch out for worn cable insulation and pinched leads.

RAPID DIAGNOSIS CHART

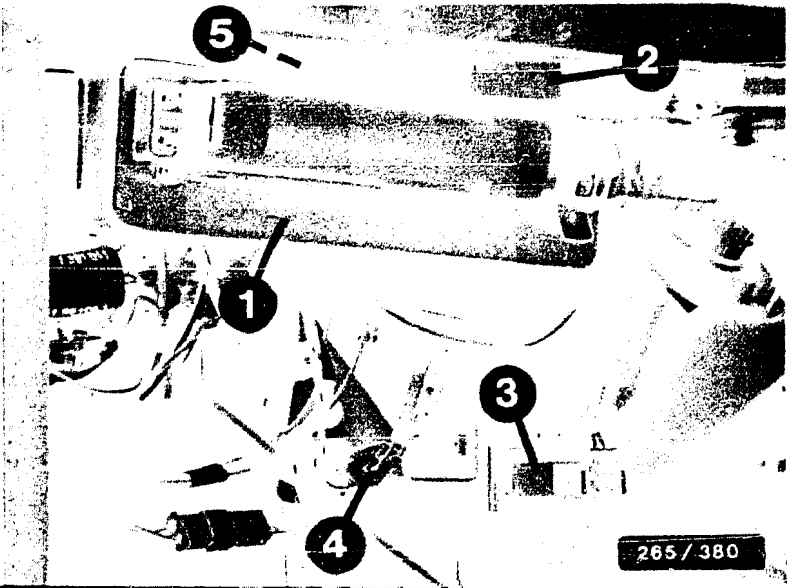
Do not drive with tester connected. Are all test conditions met?

Program-switch positions 1 to 6

Testing of (measurement at terminals)	Additional operation	Test specifi- cation (reading)	Possible causes of faults
Power supply (term.1 und term.20)	Ignition on	LED 1 (top picture) continuously lit	<ul style="list-style-type: none">*Battery insufficiently charged*High voltage drops*Overvoltage-protection relay defective*Check lead to ignition and starting switch, term. 15



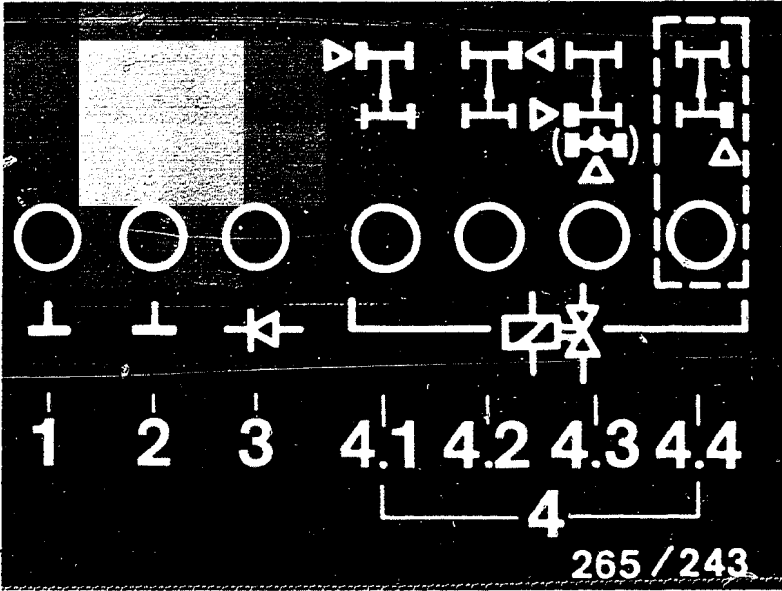
- 1 = Controller
- 2 = Overvoltage-protection relay
- 3 = Stop-lamp switch
- 4 = Clutch switch
- 5 = Ground terminal



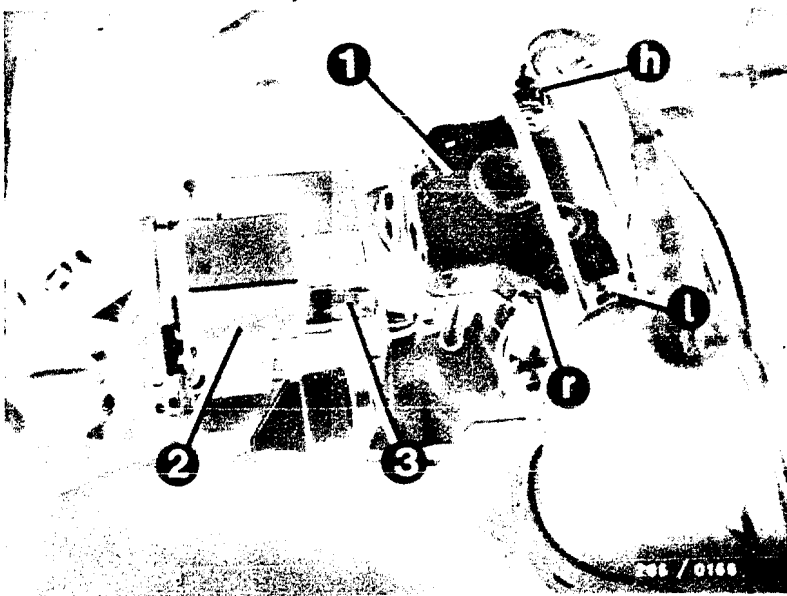
RAPID DIAGNOSIS CHART (CONTINUED)

Program-switch position 1 (3-channel hydraulic modulator)

Testing of (measurement at terminals)	Addition- al operation	Test specifi- cation (reading)	Possible causes of faults
Ground connection (term.10, term.34) Diode for warning lamp (term.29, term.32) Solenoid-operated valve internal res. (term.2, term.18, term.—, term.35) Off-position and ground connection of relay ABS warning lamp	Ignition on	6 LED (1 to 4.3) simultaneously brightly lit (top picture) ABS warning lamp in vehicle must light up	<ul style="list-style-type: none">* LED 1 and/or 2 (top picture) not lit: Check ground terminals for open circuit.* LED 3 (top picture) not lit: Diode defective, check ground connection of valve relay.* One or more LEDs 4 not lit: Check corresponding plug-in connection for solenoid- operated valve and leads.Solenoid-operated valve internal resistance 0,7...1,7 Ω* All LEDs 4 and LEDs 3 not lit: Check ground connection of valve relay, valve relay defective.* Dimmer lighting-up of an LED means contact resistance in the corresponding circuit.* ABS warning lamp not lit: Warning lamp defective. Note: all other 6 LEDs lit.



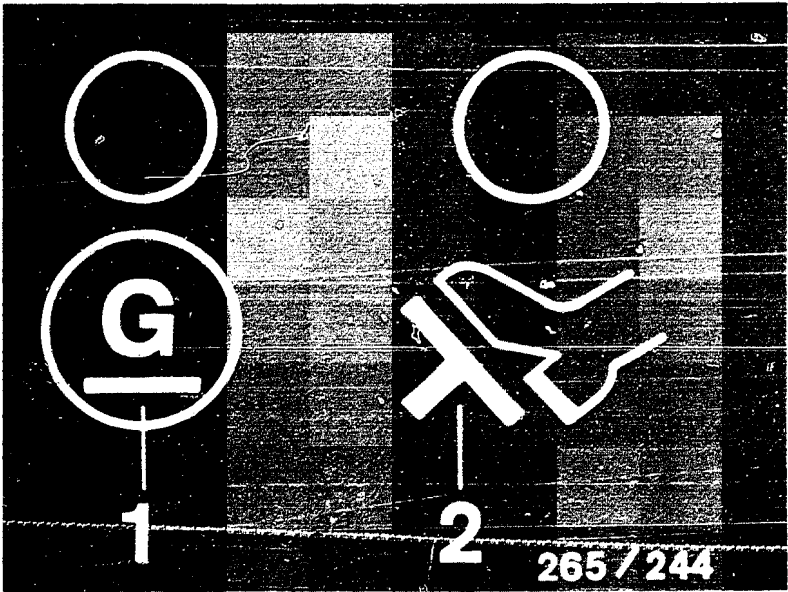
- 1 = Hydraulic modulator
- 2 = Motor relay
- 3 = Valve relay



RAPID DIAGNOSIS CHART (CONTINUED)

Program-selector-switch position 2

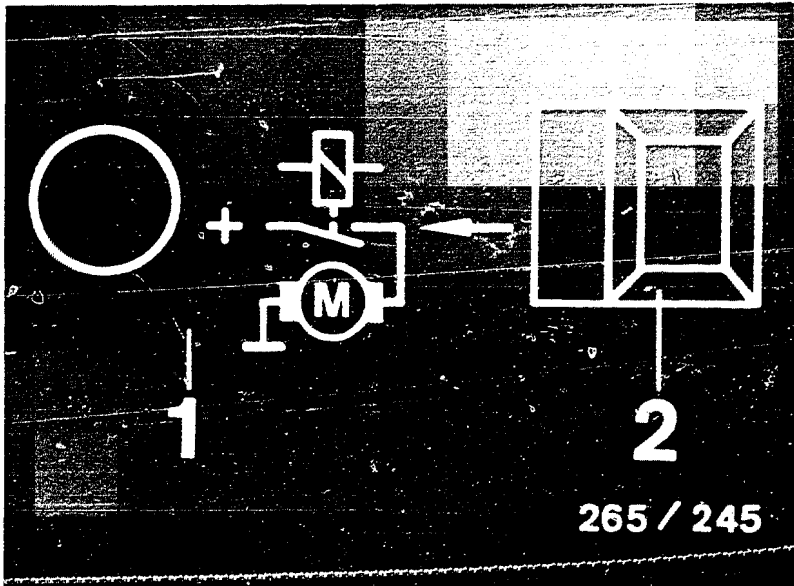
Under test (Measurement at the terminals)	Additional operation	Test specifi- cation (reading)	Possible causes of trouble
Alternator voltage from term. 61/D+ (term. 15)	Ignition on	LED 1 (top picture) lit.	* In some cases, LED does not go out until after burst of throttle (test is O.K. in this case).
	Start engine	LED 1 (top picture) goes out when engine running	* Test lead and signal from alternator term. 61 * Alternator defective.
Stop-lamp switch (term. 25)	Ignition on	LED 2 (top picture) lit	* Stop-lamp switch defective. * Check lead to stop-lamp switch.
	Press brake pedal	LED 2 (top picture) goes out	* Lead incorrectly connected to to stop-lamp switch.



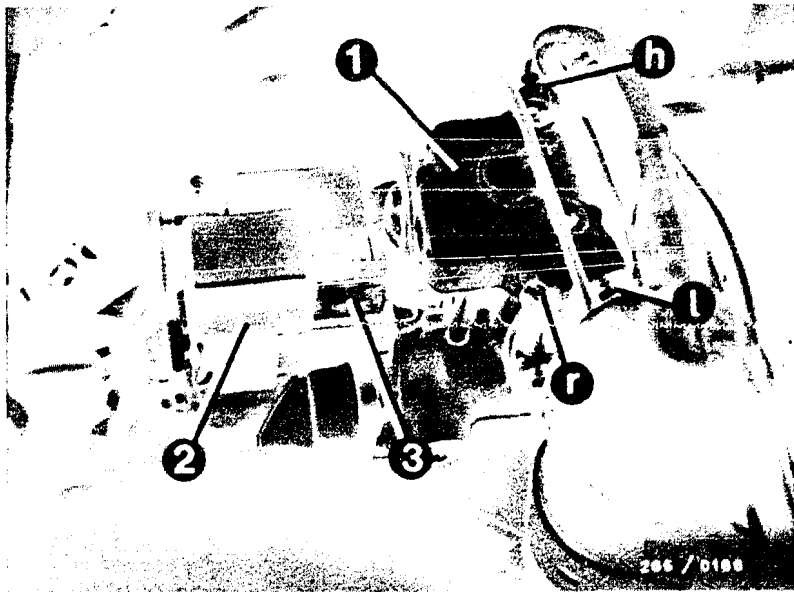
RAPID DIAGNOSIS CHART (CONTINUED)

Program-switch position 3

Testing of (measurement at terminals)	Additional operation	Test specifi- cations (reading)	Possible causes of faults
Motor relay, Pump motor in hydraulic modulator (term.28 and term.14)	Ignition on, Press button 2 continuously (top picture)	LED 1 lit, pump motor running. After button is released, LED continues to light due to running-on of motor (top picture).	<ul style="list-style-type: none">* Motor relay defective* Check ground connection and positive terminal of hydraulic modulator* Check leads from controller term.14 and term.28 to hydraulic modulator term.9 and term. 11.* Pump motor defective



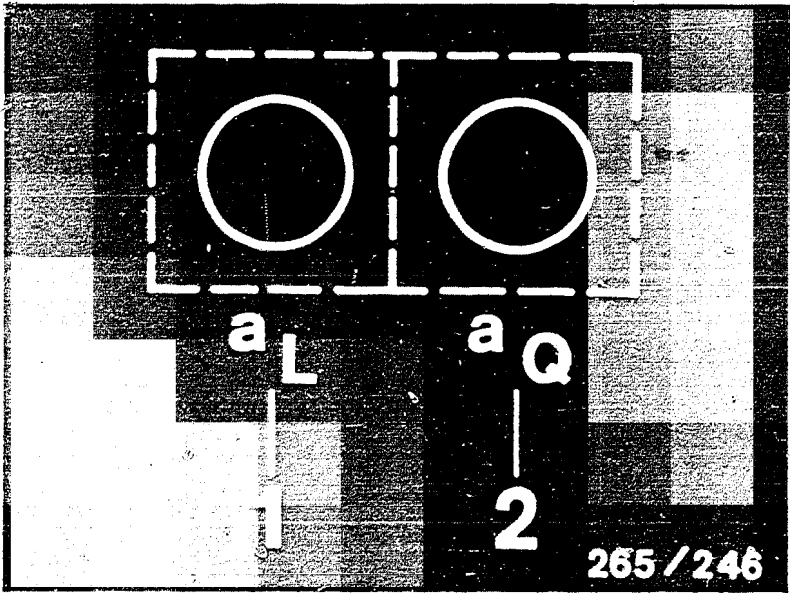
1 = Hydraulic modulator
2 = Motor relay
3 = Valve relay



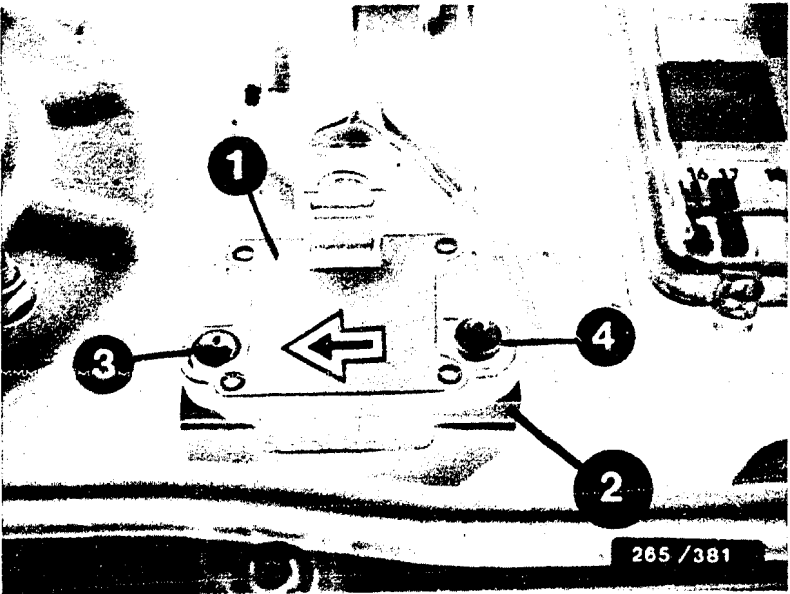
RAPID DIAGNOSIS CHART (CONTINUED)

Program-selector-switch position 4

Under test (measurement at the terminals)	Addition- al operation	Test specification (reading)	Possible causes of trouble
Acceleration sensor a L (term.16)	Ignition on	LED a L lights up	<ul style="list-style-type: none">* Check acceleration sensor: resistance value: <100 Ω Exchange sensor: drill out shear-head screw. Adjust sensor with special tool Pay attention to installation position. Use new shear-head screws.* Check lead from acceleration sensor to ABS controller term.16.* Check lead from controller term.1 to acceleration sensor.

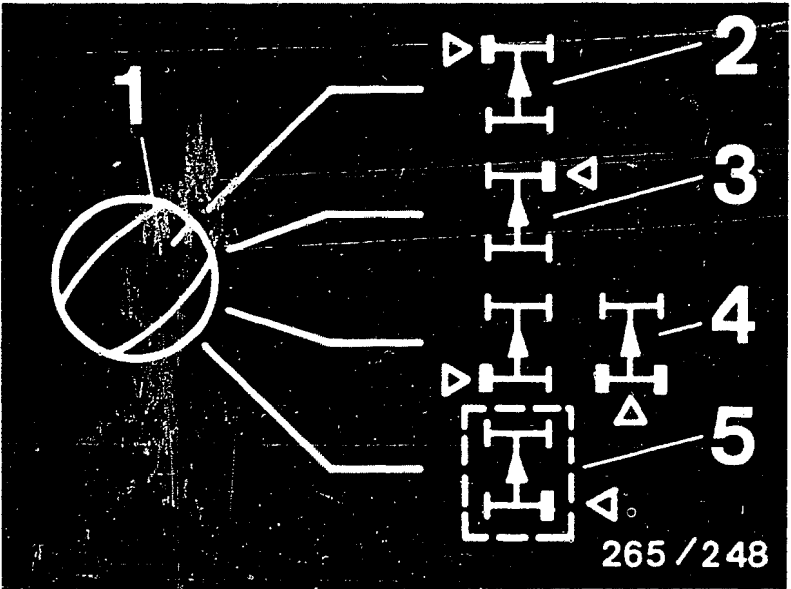
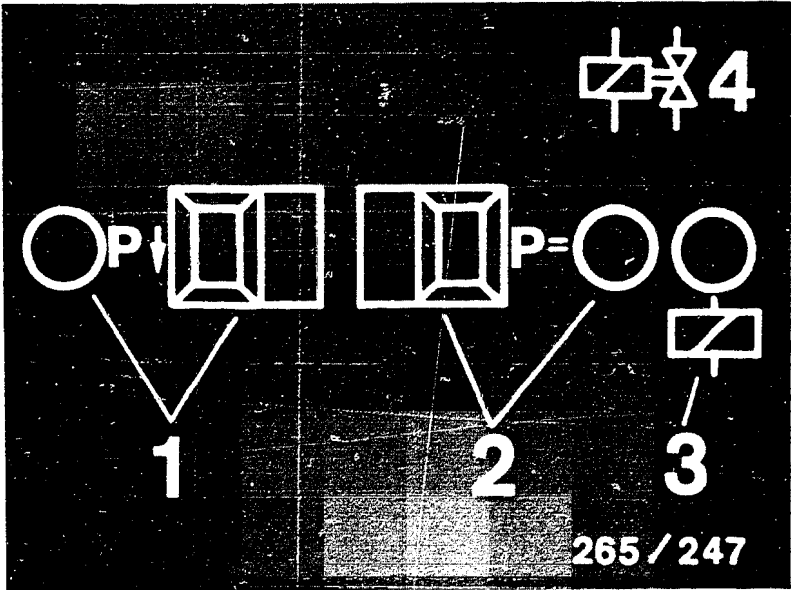


- 1 = Acceleration sensor
 - 2 = Chock
 - 3 = Shear-head screw, front
 - 4 = Shear-head screw, rear
- Arrow = Forward direction of travel



RAPID DIAGNOSIS CHART (CONTINUED)
 Program-selector-switch position 5 (3-channel hydraulic modulator)

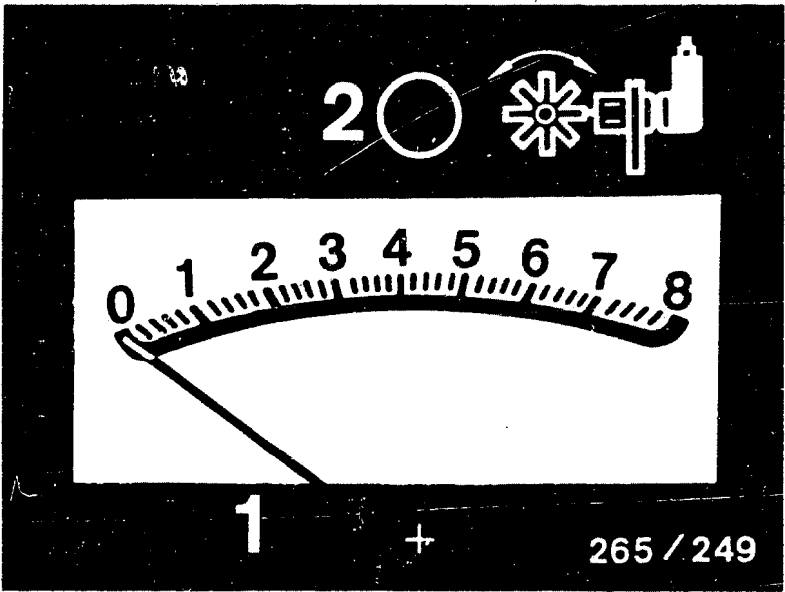
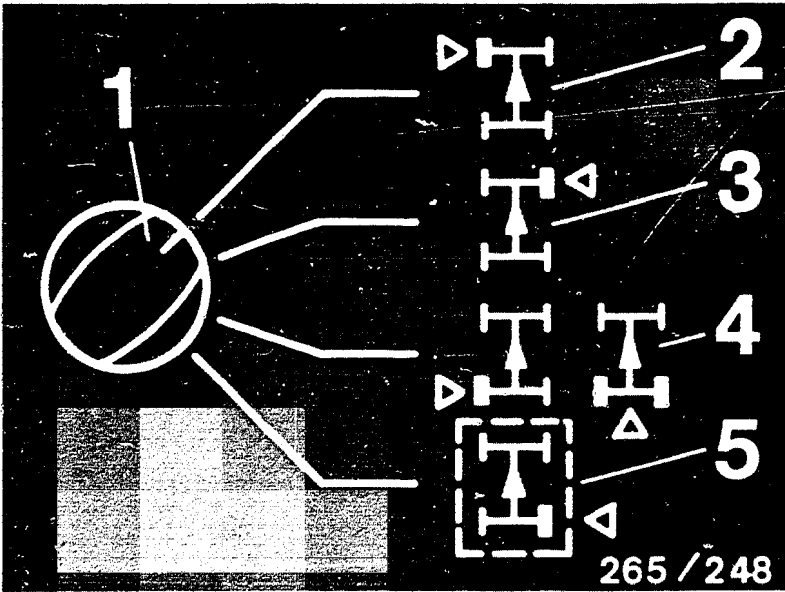
Under test (measurement at the terminals)	Additional operation	Test specification (reading)	Possible causes of trouble
Valve-relay operation (term.27)	Ignition on	LED 3 (upper illustration) lights up	*Valve relay (winding) or leads defective
Solenoid-operated valve in hydraulic modulator for operation and mix-up. NOTE: Check each wheel separately in turn. Keep to operating sequence!	Choke up vehicle. Ignition on. The wheel being tested must be freely turnable by hand. Set switch 1 for wheel selection to wheel to be tested. For the rear axle, set to position 4 (lower illustration).		* Repeat test with engine running * Valve relay (make contact) defective * Break in line from valve relay term. 87 to batt. +ve * Brake leads at hydraulic modulator mixed up
Operation pressure holding	1. Constantly press push- button P= (lower illus.)	LED P= (lower illus.) lights up	* Current value not obtained (LED P arrow or P= goes out; upper illustration): battery insufficiently charged. Repeat check with engine running.
	2. Constantly depress brake pedal	Wheel turnable by hand	
	3. Release push- button P= (upper illustration)	LED P= goes out (upper illus.) Wheel locks	
Operation pressure reduction	4. Press push- button P arrow (upper illustration)	LED P arrow (upper illustration) lights up, wheel turnable by hand	* Solenoid-op. valves correct- ly connected electrically? Wheel, front left: term.2 Wheel, front right: term.35 Wheel, rear left: term.— Wheel, rear right: term.— Rear axle: term.18 * Hydraulic modulator defective
	5.Release push- button P arrow (upper illustration)	LED P arrow (upper illus- tration) goes out, wheel locks	
	6.Release brake pedal		



RAPID DIAGNOSIS CHART (CONTINUED)

Program-selector-switch position 6 (4 wheel-speed sensors)

Under test (measurement at the terminals)	Additional operation	Test specification (reading)	Possible causes of trouble
<p>Wheel-speed sensor for operation and mix-up</p> <p>NOTE: Check each wheel separately in turn.</p> <p>Wheel, front left: term.4 and term.0,6...1,6</p> <p>Wheel, front right: term.11 and term.21</p> <p>Wheel, rear left: term.8 and term.9</p> <p>Wheel, rear right: term.24 and term.26)</p>	<p>Chock up vehicle. Ignition on.</p> <p>The wheel being tested must be freely turnable by hand.</p> <p>When testing the driven axle, the wheel not being tested must be locked.</p> <p>Set switch for wheel selection to wheel to be tested (lower illustration)</p> <p>Turn wheel by hand until LED 2 above instrument lights up without flickering. (Wheel speed approx. 1 revolution per second). Afterwards, read off indication at instrument: (upper illustration)</p>	<p>1.Smallest reading larger 1,6 divisions</p> <p>2.Permissible fluctu- ation max. 25 % of largest reading.</p>	<p>*Wheel-speed-sensor lead mixed up</p> <p>*Break in wheel-speed- sensor lead</p> <p>*Wheel-speed sensor defective Winding resistance Front axle: 0,6...1,6 k Ω Rear axle: 22 k Ω</p> <p>*Air gap between wheel-speed sensor and ring gear too wide</p> <p>*Ring gear defective or loose</p> <p>*Ring gear with incorrect number of teeth installed Front axle: 48 teeth Reat axle: <u>48</u> teeth</p> <p>*Wheel-bearing clearance too large</p> <p>*Reading appears, LED 2 does not light up: loose contact in wheel- speed-sensor lead.</p>



Continue test with next coordinate.

Check engine-drag-torque control:

The engine speed and ignition are influenced by the Motronic (as of M1.1 with 55-pin plug).

Switch off ignition and disconnect ABS controller and throttle-valve-switch plug.

Run engine at approx. 3000 min⁻¹ without loading.

Using suitable lead, bridge term. 2 and term. 18 in the throttle-valve-switch plug (this simulates closed idle contact).

Engine "hunts".

Afterwards, bridge term. 1 (batt. +ve) and term. 3 on controller plug.

Set value: engine speed increases again to 3000 min⁻¹, i.e. the overrun cut-off is raised.

Operation not O.K.:

+Check lead from ABS controller plug term. 3 to Motronic control-unit plug term. 50 over engine plug term. 17.

+Check lead from throttle-valve-switch plug term. 2 and term. 18 to Motronic control-unit plug term. 52 and ground.

+Motronic control unit defective..

Clutch switch:

*Ignition off. Disconnect controller plug.

Connect voltmeter to term. 33 (+) and ground.

Ignition on and depress brake pedal:

Voltage must be greater than 10 V.

Fully depress clutch: voltage 0 V.

If operation not O.K., check switch and leads; adjust switch.

Final check: take for road test driving faster than 30 km/h for at least 20 seconds, and at at least 50 km/h for at least 3 seconds. The warning lamp must not light up.

TEST SPECIFICATIONS

Wheel-speed sensor

* Winding resistance at ambient temperature (-10°C...+120°C) for front axle:	600...1600 Ω
rear axle:	600...1600 Ω

Hydraulic-modulator solenoid-operated valves

* Winding resistance at ambient temperature (-10°C...+120°C):	0,7...1,7 Ω
---	-------------

Air gap:	0,8 ± 0,5 mm
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Tightening torque for

* Fastening screws of wheel-speed sensor:	> 8 Nm
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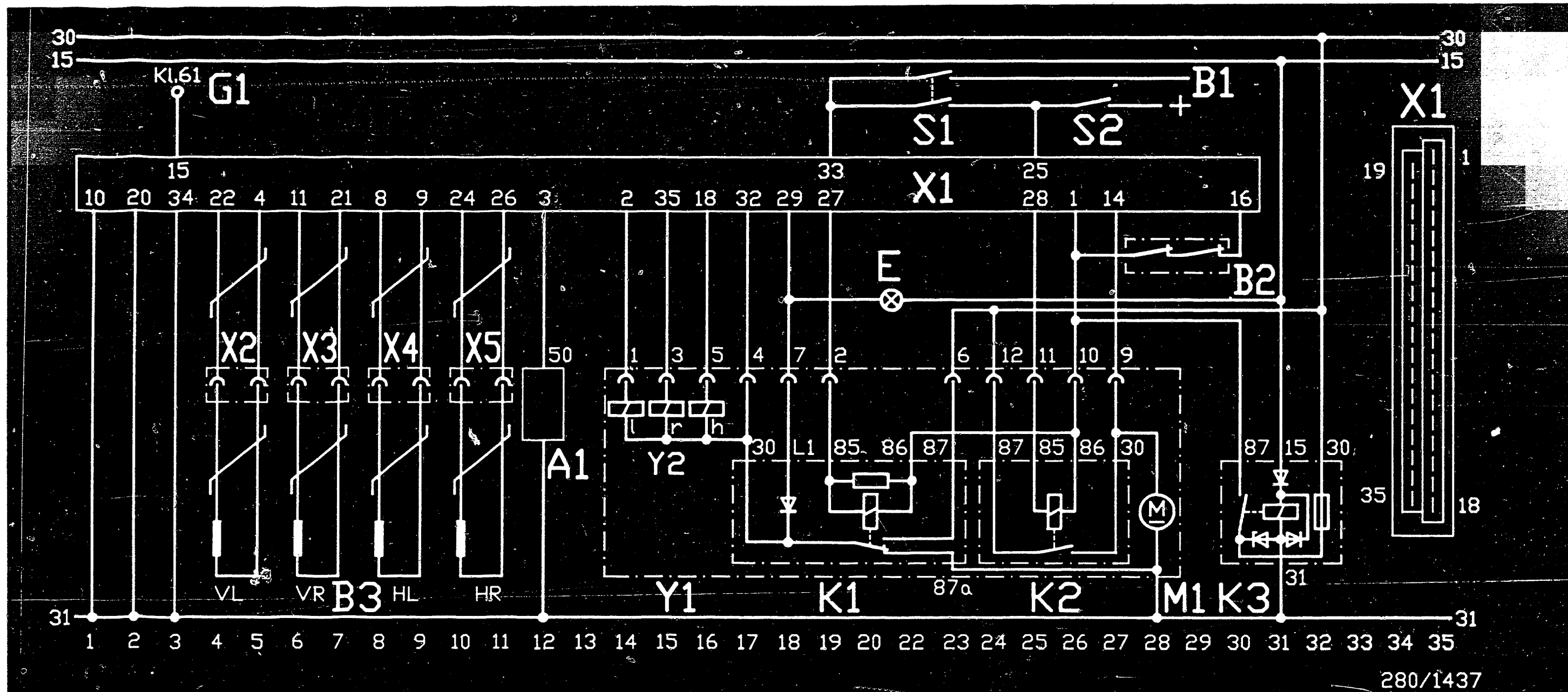
* Brake-line connections on hydraulic modulator:	12...16 Nm
--	------------

Number of teeth

* Front axle:	48 teeth
* Rear axle:	48 teeth

Acceleration sensor

* Contacts closed in horizontal position:	< 100 Ω
---	---------



280/1437

A1 = Motronic control unit (55-pin)

B1 = Tempomat

B2 = Acceleration sensor

B3 = Wheel-speed sensor

E = ABS warning lamp

G1 = To alternator

K1 = Valve relay as of 8.87

K2 = Motor relay

K3 = Overvoltage-protection relay

M1 = Return-supply-pump motor

S1 = Clutch switch

S2 = Stop-lamp switch

X1 = Controller plug (35-pin)

X2...X5 = Multiple butt connector

Y1 = Hydraulic modulator

Y2 = Solenoid-operated valves

VL = l = Front left

VR = r = Front right

HA = h = Rear axle

HL = = Rear left

HR = = Rear right

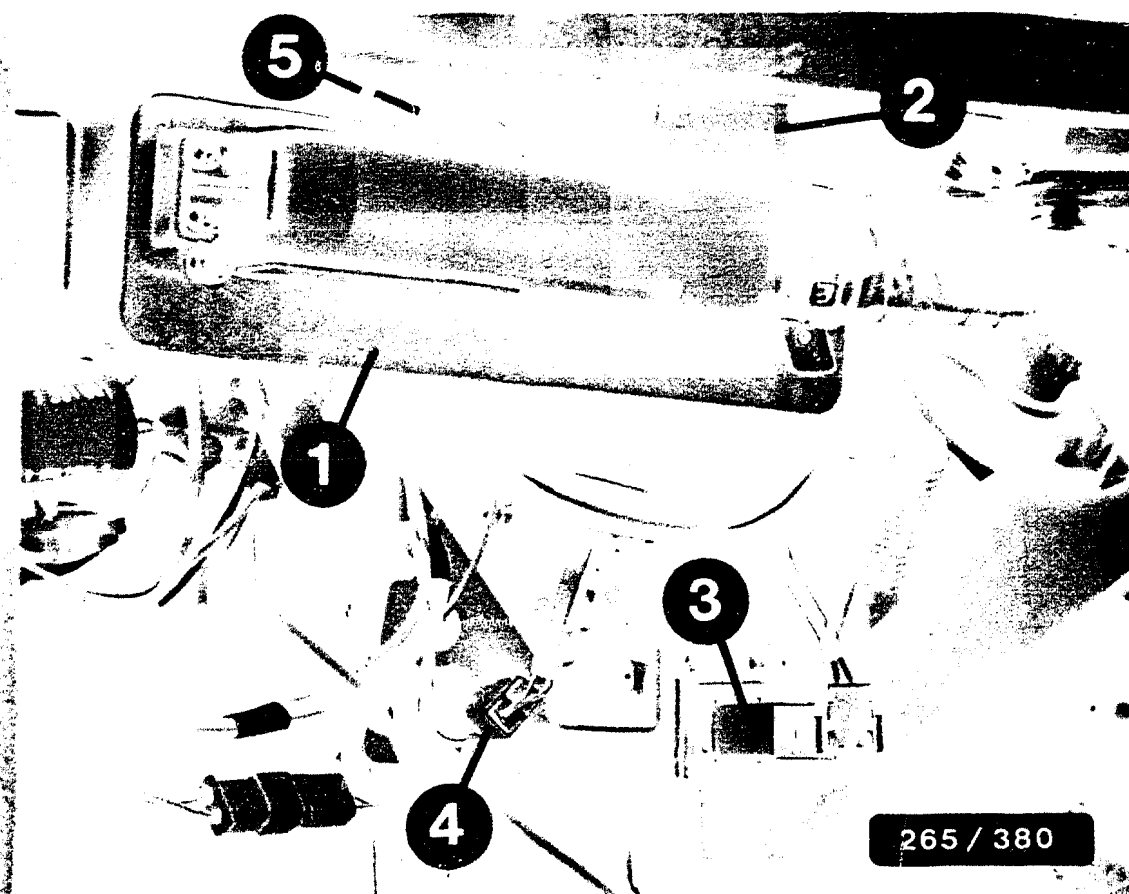
ELECTRICAL TERMINAL DIAGRAM 1.87->

J21

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J22

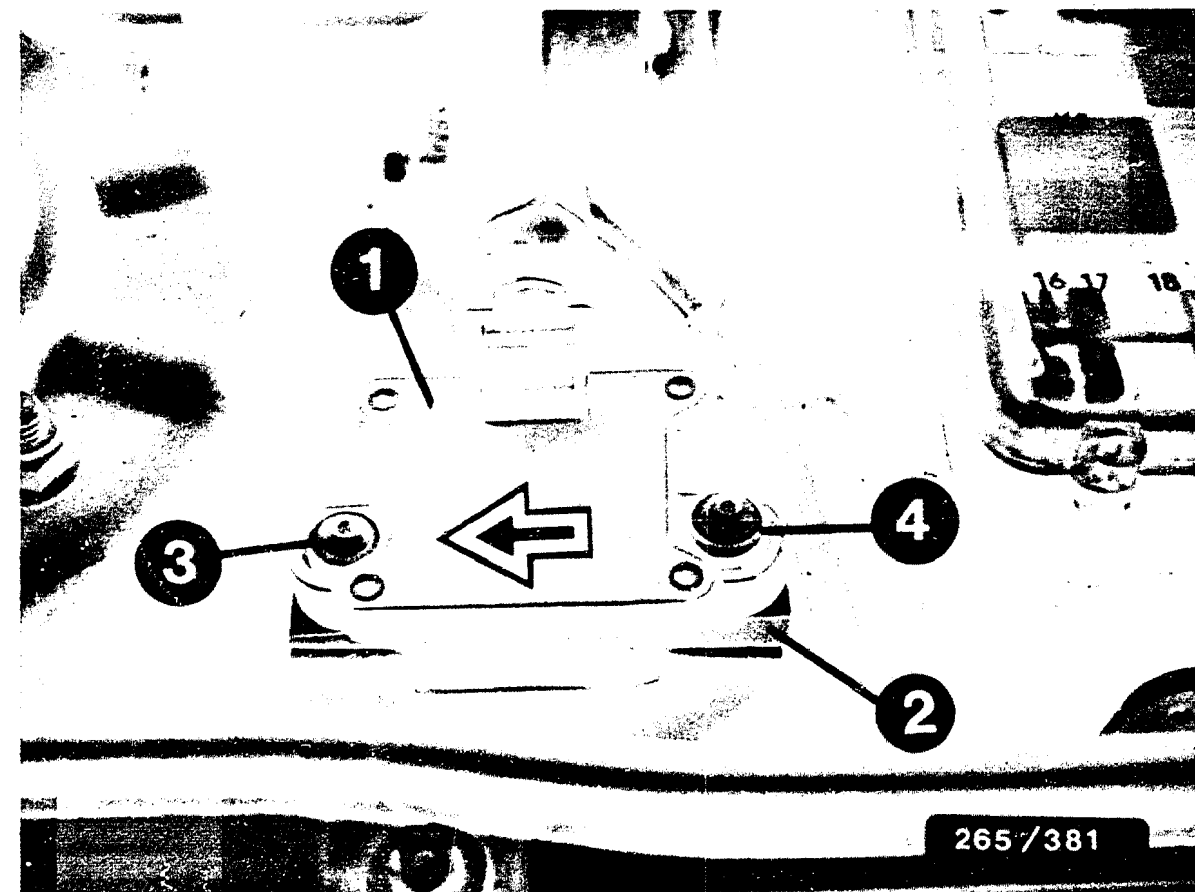
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INSTALLATION POSITION OF COMPONENTS

The indications "right" and "left" always refer to the forward direction of travel.

- * Controller (Item. 1):
to the left of the steering column behind the footwell panelling.
- * Overvoltage-protection relay (Item 2):
on the right above the controller.
- * Stop-lamp switch (Item. 3):
on the brake pedal.
- * Clutch switch (Item 4):
on the clutch pedal.
- * Ground terminal (Item 5) for ABS:
behind the controller.
- * ABS warning lamp: in the instrument panel.
- * Battery: in the luggage compartment on the right.



- 1 = Acceleration sensor
- 2 = Chock
- 3 = Shear-head screw, front
- 4 = Shear-head screw, rear
- Arrow = Forward direction of travel

INSTALLATION POSITION OF COMPONENTS (Continued)

Exchange accelerator sensor:
drill out shear-head screws. Adjust sensor using special tool. Pay attention to direction of installation. Use new shear-head screws.

- * Wheel-speed sensors, front axle:
left and right in the steering knuckles.
Do not mix up the left-hand and the right-hand wheel-speed sensors when installing.
- * Wheel-speed sensors, rear axle:
left and right near to the brake calipers.
- * Ground cables for pump motor and valve relay (->8.87):
in the engine compartment on the left-hand side on the bodywork.

INSTALLATION POSITION OF COMPONENTS (Continued)

* Hydraulic modulator:

In the engine compartment behind the left-hand headlamp.

The hydraulic modulator must not be repaired, but be exchanged as a complete unit.

E x c e p t i o n : The relays may be changed.

For production reasons:
continued on the following
coordinate.

TABLE OF CONTENTS

Trouble-shooting instructions : VWV-5000

BOSCH System : ABS

Make of vehicle : VW (Volkswagen)

Basic microcard : ALL-507

Test instructions	Coordinates
Table of contents.....	E02
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SPECIAL FEATURES

This microcard contains the trouble-shooting instructions, valid at the time of publication, for the following model:

* VW Passat Syncro Injection (9.1986 ->)

Test with ABS2 LED tester.

The ABS for this vehicle operates with 4 wheel-speed sensors and 3 hydraulic ducts.

The vehicles are equipped with an interaxle differential lock and a rear-axle differential lock. They can be engaged and disengaged via a 2-stage push-pull switch.

When a lock is engaged, the ABS is automatically switched off.

The driver may decide whether to drive with ABS or differential lock.

Via the push-pull switch, intake-manifold pressure reaches a pneumatic final controlling element which brings the lock in the differential into operation via an actuation lever.

When the lock is switched, an electric switch at the differential is mechanically actuated and this switches the current supply for the ABS off.

In addition to the ABS indicator lamp, the indicator lamp for the corresponding differential lock lights up simultaneously.

TEST SPECIFICATIONS / TEST REQUIREMENTS

For reasons of safety, the ABS must be tested only with the ABS tester. The rapid diagnosis chart contains all the important test specifications together with instructions for testing and trouble-shooting.

TEST REQUIREMENTS FOR TESTING WITH ABS2 LED TESTER

- * Regulator ~~the~~ size fitted?
- * Check for firm seating and corrosion of ground of return supply pump and of combi relay term.31 .
- * Check for leaks in hydraulic connections and sealing points at hydraulic modulator (visual examination).
- * If the ABS warning lamp lights up intermittently when driving (e.g. after switching on consuming devices) and goes out again by itself, check the battery and power supply (generator, regulator and voltage drops).
- * If the ABS warning lamp lights up constantly and does not go out, check the following points:
 - Multiple plug sitting correctly on controller and latched?
 - All plug contacts O.K.?
 - Spring contacts latched?
 - Check installation position for correct seating of seal ring in controller plug:
rounded side downwards.

- Check wheel-speed-sensor leads for correct assignment at controller plug:

Wheel-speed sensors:

front left to term. 22 and term. 4.
front right to term. 23 and term. 21.
rear left to term. 8 and term. 9.
rear right to term. 24 and term. 26.
rear axle to term. - and term. -.

- V-belt snapped?
(Alternator provides no voltage, charge-indicator lamp and ABS warning lamp light up).
- * Connect ABS 2 LED tester to ABS wiring harness.
- Disconnect and connect controller only with ignition switched off.
- For testing, switch on ignition in all program-selector-switch positions (tester operates with current supply from vehicle battery).
- Observe LED (green) for current supply in all program-selector-switch positions.

CAUTION !

Do not drive with tester connected!

The brake system must be bled of air before the ABS test. Do not activate the ABS tester while the system is being bled.

Repeat the complete test program after any repairs are carried out.

The Antiskid System is a vehicle safety system.

Work on the system demands detailed knowledge of the system.

The conventional brake system must be O.K.

General information for trouble-shooting:

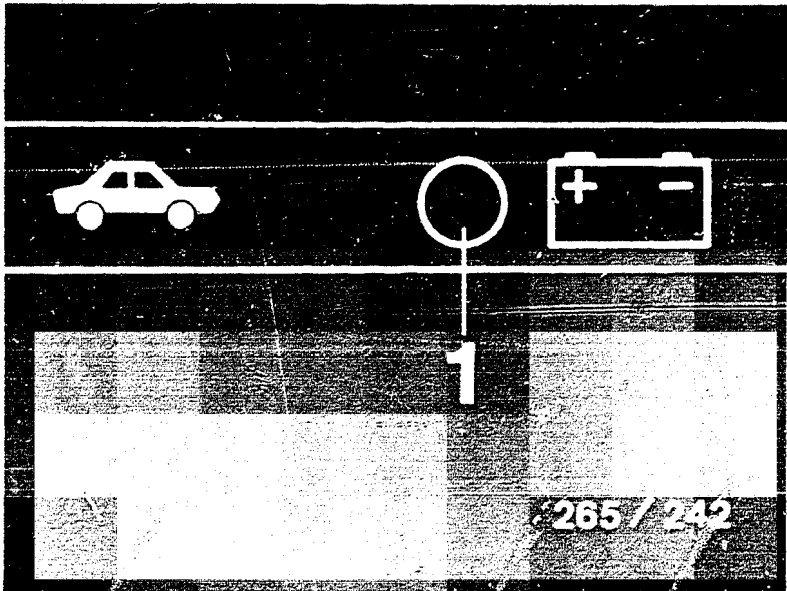
Check all leads for short circuit to ground and contact with positive leads and watch out for worn cable insulation and pinched leads.

RAPID DIAGNOSIS CHART FOR ABS 2 LED TESTER

Do not drive with tester connected!

Program-selector-switch position 1 to 6

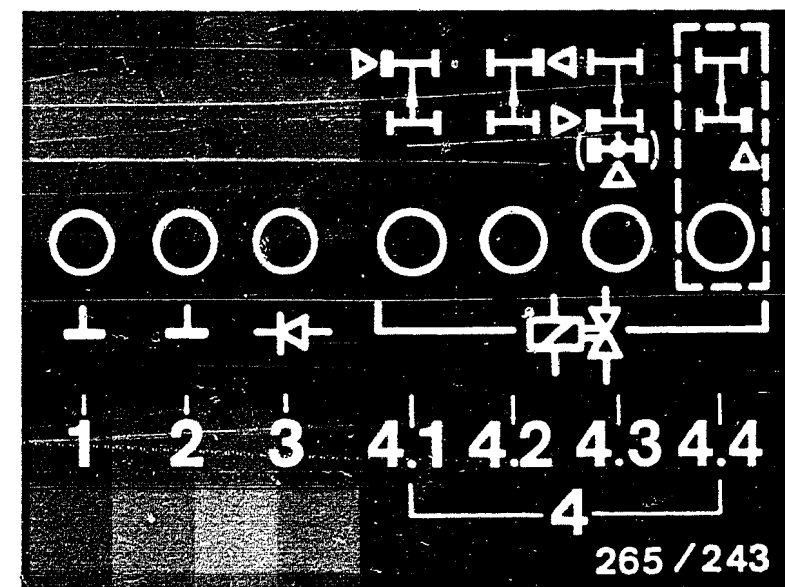
Under test (measurement at terminals)	Additional operation	Test specif- ication (reading)	Possible causes of trouble (see coordinate)
Voltage supply term. 1 and term. 20)	Ignition on	LED 1 (upper illustration) lights up constantly	<ul style="list-style-type: none">* 4-pin plug-in connection defec- tive (-)* Battery insufficiently charged* Voltage drops too high (-)* Overvoltage-protection relay defective (-)* Check lead to driving switch term. 15



Rapid diagnosis chart (Continued 1)

Program-selector-switch position 1 (3-duct hydraulic modulator)

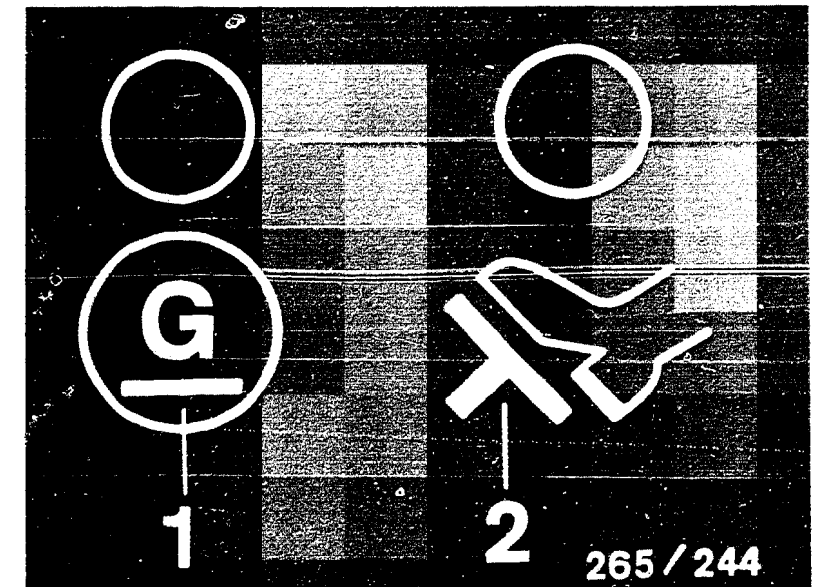
Test on (measurement at terminals)	Addit- ional operation	Test specification (reading)	Possible causes of trouble (see coordinate)
Ground (term.10, term.34) Diode for warning lamp (term.29, term.32) Solenoid-operated valve internal resistances (term.2, term.18, term.-, term.35) Off-position and ground of valve relay ABS warning lamp	Ignition on	6 LEDs (1 to 4,3) light up equal- ly brightly (upper ill.) ABS warning lamp in vehicle must light up	<p>* LED 1 and / or 2 (upper illustration) do not light up: Check ground terminals for short circuit. (-)</p> <p>* LED 3 (upper illustration) does not light up: diode defective, check ground of valve relay. (-)</p> <p>* One or more LED 4 do not light up: Check corresponding plug connection for solenoid-operated valve and leads. (-)</p> <p>Solenoid-operated valve, internal resistance 0,7...1,7 Ω</p> <p>* All LED 4 and LED 3 do not light up: Check ground of valve relay, valve relay defective. (-)</p> <p>* Weak lighting of a LED means contact resistance in corresponding current path. (-)</p> <p>* ABS warning lamp does not light up: warning lamp defective. Note: all other 7 LEDs light up (-)</p>



RAPID DIAGNOSIS CHART (CONTINUATION 2)

Program-selector-switch position 2

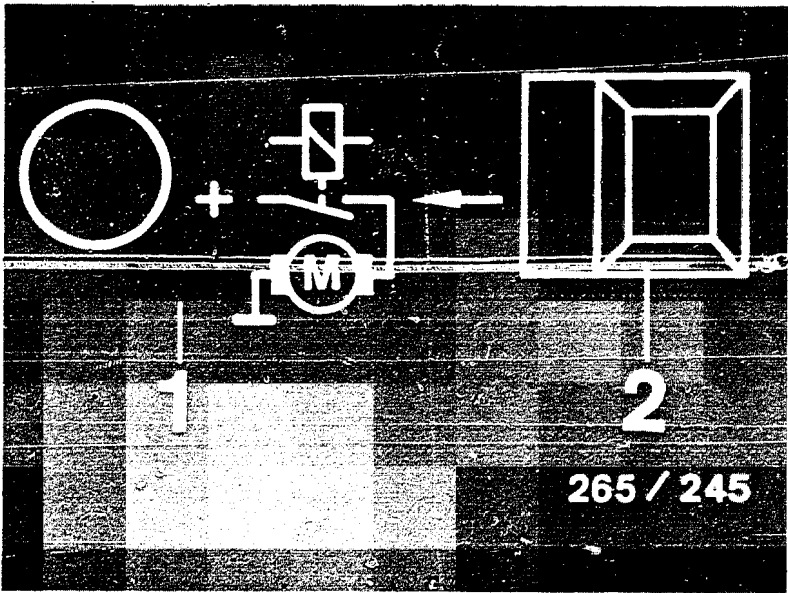
Test on (Measurement at terminals)	Additional operation	Test specification (reading)	Possible causes of trouble (see coordinate)
Generator voltage of term. 61 term. 15)	Ignition on	LED 1 (upper illustration) lights up.	* LED sometimes goes out only after snap acceleration (test is then O.K.) (-)
	Start engine	LED 1 (upper illustration) goes out with engine running	* Check lead to generator term. 61 * Generator defective.
Stop-lamp switch (term. 25)	Ignition on	LED 2 (upper illustration) lights up	* Stop-lamp switch defective. (-) * Check lead to stop-lamp switch.
	Actuate brake pedal	LED 2 (upper illustration) goes out	* Lead at stop-lamp switch incorrectly connected.



Rapid diagnosis chart (Continued 3)

Program-selector-switch position 3

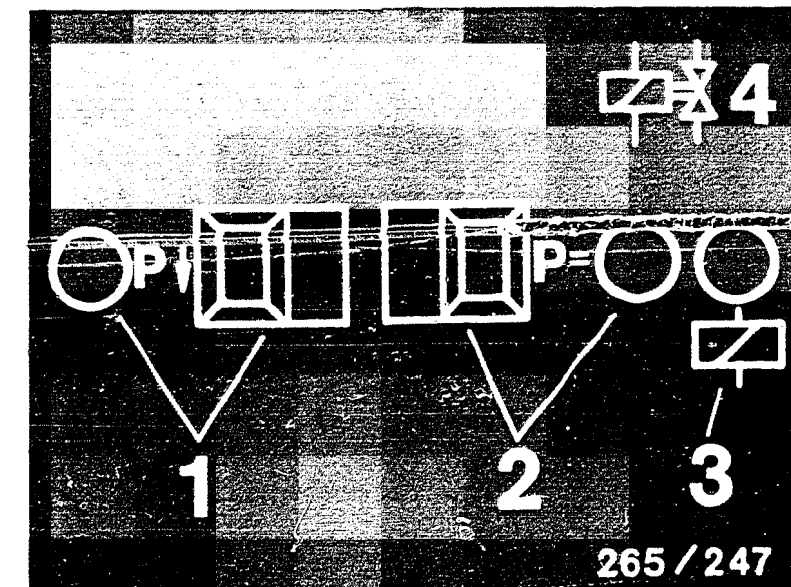
Test on (measurement at terminals)	Additional operation	Test specifications (reading)	Possible causes of trouble (see coordinate)
Motor relay, pump motor in hydraulic modulator (term.14 and term.28)	Ignition on, constantly press push- button 2 (upper ill- ustration)	LED 1 lights up, pump motor runs. After releasing push-button, LED stays lit due to run-on of motor (upper illustration).	<ul style="list-style-type: none">* Motor relay defective (-)* Check ground and positive terminal of hydraulic modulator (-)* Check leads from controller term.14 and term.28 to hydraulic modulator term.9 or term.11. (-)* Pump motor defective (-)



Program-selector-switch position 4 not applicable

RAPID DIAGNOSIS CHART (CONTINUED 4)
 Program-selector-switch position 5 (3-channel hydraulic modulator)

Test on (measurement at terminals)	Additional operation	Test specification (reading)	Possible causes of trouble (see coordinate)
Valve relay op. (term.27)	Ignition on	LED 3 (upper illustration) lights up	*Valve relay (winding) or leads defective (-)
Solenoid-operated valves in hydraulic mod. for function and mix-up. NOTE: Check each wheel separately in turn. Keep to operating sequence!	Chock up vehicle. Ignition on. The wheel being tested must be freely turnable by hand. Set switch 1 for wheel selection to wheel to be tested. (Lower ill.)		<ul style="list-style-type: none"> * Repeat test with engine running * Valve relay (make contact) defective (-) * Brake in line from valve relay term.87 to B+ (-) * Brake leads at hydraulic modulator mixed up (-)
Operation pressure holding	1. Constantly press push-btn P= (upper ill.)	LED P= (upper ill.) lights up	<ul style="list-style-type: none"> * Current value not obtained (LED P arrow or P= goes out; upper illustration): Battery insufficiently charged. Repeat test with engine running. (-)
	2. Constantly press brake pedal	Wheel turnable by hand	
	3. Release push- button P= (upper ill.)	LED P= goes out (upper ill.) Wheel locks	
Operation pressure reduction	4. Press push- button P arrow (upper illustration)	LED P arrow (upper ill.) lights up, wheel turnable by hand	<ul style="list-style-type: none"> * Solenoid-op. valves correct- ly connected electrically? Wheel, front left:term.2 Wheel, front right:term.35 Wheel, rear left:term.- Wheel, rear right:term.- Rear axle:term.18 (-) * Hydraulic modulator defective (-)
	5.Release push- button P arrow (upper ill.)	LED P arrow (upper ill.) goes out, wheel locks	
	6.Release brake pedal		

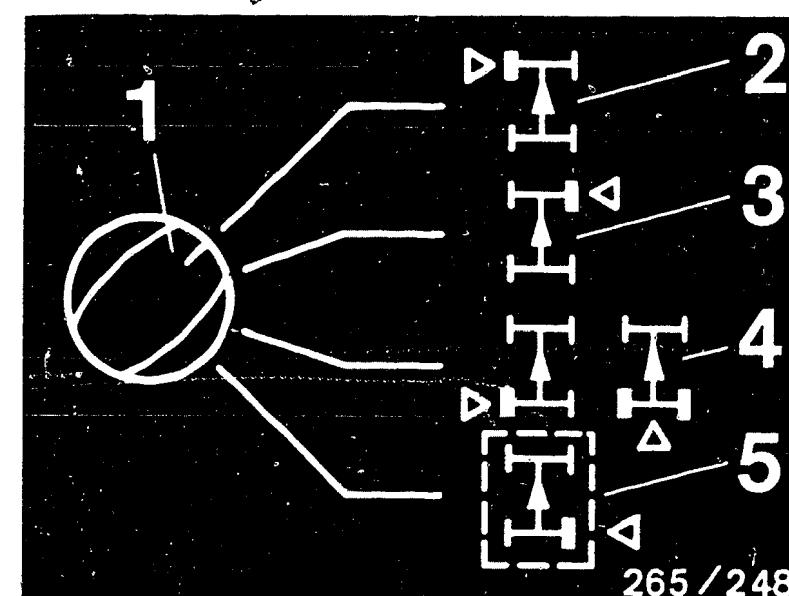
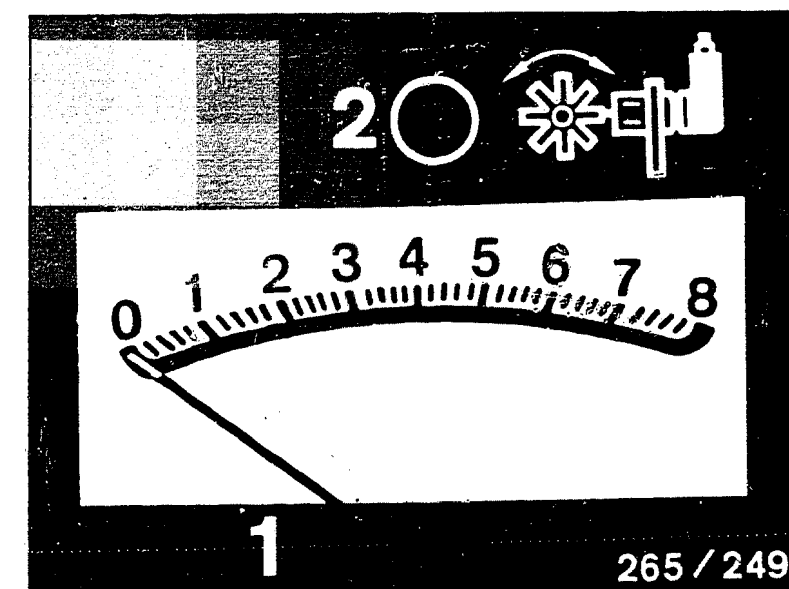


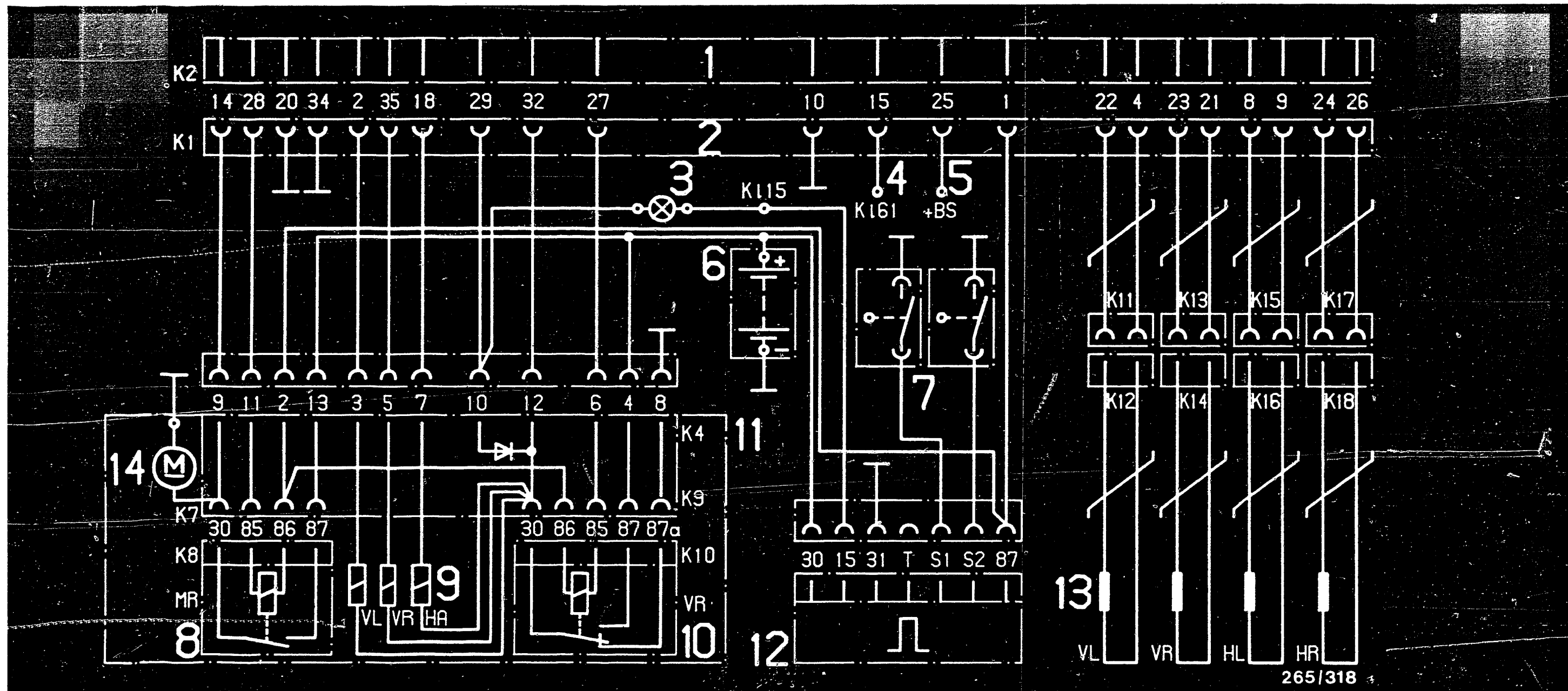
Rapid diagnosis chart (Continued 5)

Program-selector-switch position 6 (4 wheel-speed sensor)

Test on (measurement at terminals)	Additional operation	Test specification (reading)	Possible causes of trouble (see coordinate)
<p>Wheel-speed sensor for operation and mix-up</p> <p>NOTE: Check each wheel separately in turn.</p> <p>(Wheel, front left: term.4 + term.22</p> <p>Wheel, front right: term.23 + term.21</p> <p>Wheel, rear left: term.8 + term.9</p> <p>Wheel, rear right: term.24 + term.26</p>	<p>Chock up vehicle. Ignition on.</p> <p>The wheel being tested must be freely turnable by hand.</p> <p>When testing the driven axle, the wheel not being tested must be locked.</p> <p>Set switch for wheel selection to wheel to be tested (lower illustration)</p> <p>Turn wheel by hand until LED 2 above instrument lights up without flickering. (Speed approx. 1 revolution per second). Afterwards read off reading at instrument: (upper illustration)</p>	<p>1.Smallest reading larger 1,6 divisions</p> <p>2.Permissible fluctuation max. 25 % of greatest reading.</p>	<p>*Wheel-speed sensor lead mixed up (-)</p> <p>*Break in wheel-speed sensor lead (-)</p> <p>*Wheel-speed sensor defective (-)</p> <p>Winding resistance front axle: 0,8...1,8 k Ω</p> <p>rear axle: 0,8...1,8 k Ω</p> <p>*Air gap between wheel-speed sensor and ring gear too wide (-)</p> <p>*Ring gear defective or loose (-)</p> <p>*Ring gear with incorrect number of teeth installed: Front axle: (96) teeth Rear axle: (96) teeth (-)</p> <p>*Wheel-bearing clearance too large</p>

Take for road test for final check. The warning lamp must go out when the engine is running. Drive at at least 30 km/h. The warning lamp must not light up again!





ELECTRICAL TERMINAL DIAGRAM

1 = Controller
 2 = Controller plug (35-pin)
 3 = ABS warning lamp
 4 = to alternator
 5 = to stop-lamp switch
 6 = Battery
 7 = Switch for differential locks

8 = Motor relay
 9 = Solenoid-operated valves
 10 = Valve relay
 11 = Hydraulic modulator
 12 = Combi relay
 13 = Wheel-speed sensor
 14 = Return supply-pump motor

VL = front left
 VR = front right
 HA = Rear axle
 HL = rear left
 HR = rear right
 K1 to
 K22 = ABS plug
 connections

TEST EQUIPMENT AND TOOLS

Description	Designation	Part number
ABS2 LED tester	KDAS 0003	Procure. address: Robert Bosch GmbH KH/VKD 3 Postfach 41 09 60 7500 Karlsruhe 41
Adapter lead (included in scope of delivery of tester)	KDAS 0003/2	
Charging and bleeding device		e.g. ATE Part No. 3.9302-1000.4 1)
Bleeder fitting for connection of charging and bleeding device to fluid reservoir of brake master cylinder		ATE Part No. 3.9302.0702.2 1)
Bleeder hose		ATE Part No. 3.3590.2300.1 1)
Auxiliary hose		ATE Part No. 3.9302.0704.2 1)
Brake-pedal-actuating device		ATE Part No. 3.9312.0100.4 1)
Pressure tester Tester for low- and high-pressure testing, hydraulic brake systems		e.g. ATE Part No. 3.9305-0200.4 1)

TEST EQUIPMENT AND TOOLS (CONTINUED)

Designation	Code	Part number
Flat double-end flare nut wrench, 9 x 11 mm		Hazet Part No. 612 2)
Container, approx. 1 l for catching the brake fluid		
Brake fluid Use only DOT 4 or brake fluid from the vehicle manufacturer.		
Electrics tester or multimeter for trouble-shooting	ETE 014.00	0 684 101 400 Commercially available

Aid:

Use only original brake lines from the vehicle
manufacturer!

Grease for wheel-speed sensor	Molykote Longterm 2
Protective caps for brake lines	1 900 508 002 (100 pieces)
Protective caps for brake-line connections at hydraulic modulator	1 900 508 004 (100 pieces)

1) obtainable from: Alfred Teves GmbH Guerickestr. 7
D-6000 Frankfurt (Main)

2) obtainable from: Hazet, D-5630 Remscheid

INSTALLATION POSITION OF COMPONENTS

The indications "right" and "left" always refer to the forward direction of travel.

* ABS controller: (upper illustration)

In trunk, rear right, behind the trunk panelling. To remove the controller, remove trunk panelling.

* Combi relay: (center illustration)

In the fuse box, relay space 14

* ABS warning lamp:

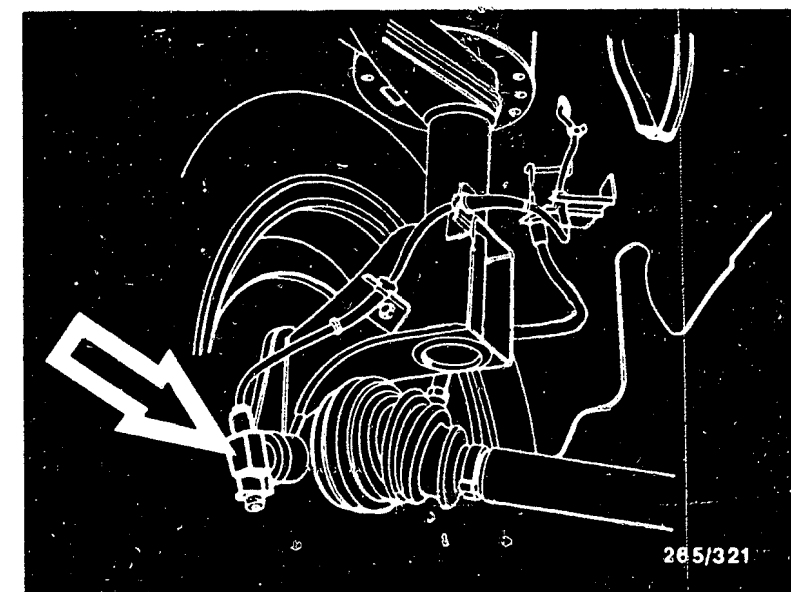
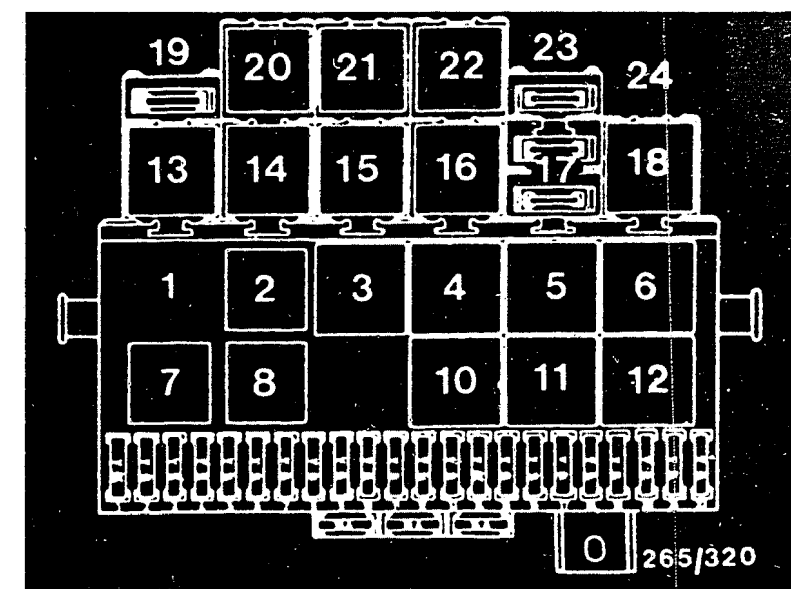
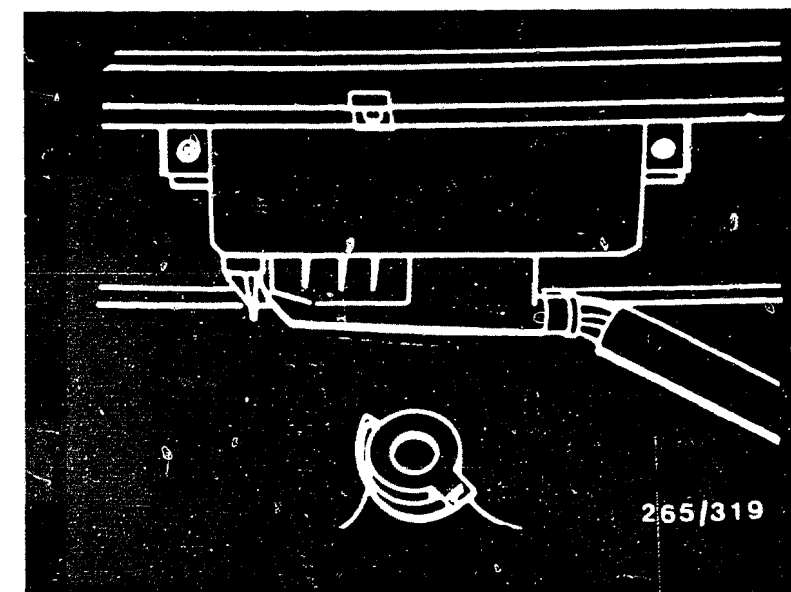
In instrument panel.

* Wheel-speed sensor, front left: (lower illustration - arrow)

Plug connection of wheel-speed sensor at left in engine compartment at McPherson strut dome.

* Wheel-speed sensor, front right:

Plug connection of wheel-speed sensor at right in engine compartment between McPherson strut dome and battery



INSTALLATION POSITION OF COMPONENTS (CONTINUATION)

- * Wheel-speed sensor, rear left: (upper illustration - arrow)

Plug connection of wheel-speed sensor at left beneath rear seat bench.

- * Wheel-speed sensor, rear right:

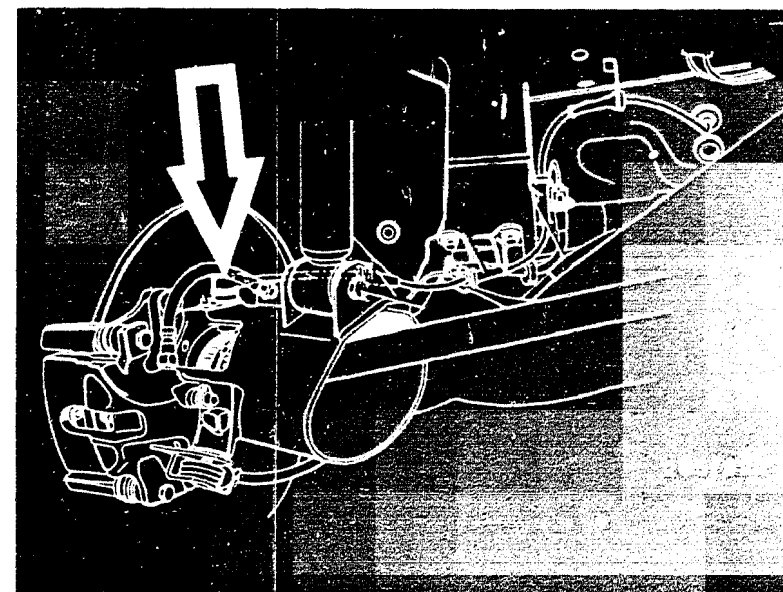
Plug connection of wheel-speed sensor at right beneath rear seat bench.

- * Hydraulic modulator:

In engine compartment near to brake master cylinder

The hydraulic modulator must not be repaired, but be exchanged only as a complete unit.

Exception: Change of relay



GENERAL INFORMATION FOR REPAIRS AND ON BRAKE SYSTEM

The ABS is basically maintenance-free, however, when working on vehicles with ABS system the following must be noted:

1. When welding with electric welding equipment, pull plug from electronic controller.
2. When painting, the electronic controller may be loaded for a short time with max. +95°C and for a long time (approx. 2 hours) with max. +85°C.
3. After exchange of hydraulic modulator, controller, wheel-speed sensor and wiring harness, as well as after work in which the ABS units are touched (e.g. accident repairs), check the complete ABS system with the tester.
Pay attention to correct assignment of brake lines and wheel-speed sensor connections to controller as well as wheel-speed sensor plug connections (see vehicle-specific terminal diagram).
4. Each time after working on the brake system, the latter must be bled and go through low-pressure and high-pressure tests. Test all junctions for leaks.
5. Tighten battery terminals securely to terminal posts of battery.
6. Do not use a fast charger for starting the engine.
7. Never disconnect the battery from the vehicle electrical system when engine is running.

8. When fast charging, disconnect the battery from the vehicle electrical system.
9. Take care that all connectors of the wiring harness are seated perfectly.
10. Never disconnect or connect the ABS wiring-harness plug from the controller when the ignition is switched on.
11. For reasons of safety, the hydraulic modulator must never be repaired, but be exchanged only as a complete unit.

Excepted from this are the motor relay and the valve relay.

Both relays may be exchanged.

Apart from the brake-line connections, no screws at the hydraulic modulator may be loosened.

Once they are loosened, it is impossible to make the brake circuits leak-free ever again!

There is danger to life !

Caution when handling brake fluid!

- a) Fill brake fluid only into containers from which no one would mistakenly drink the fluid.
(D a n g e r - p o i s o n o u s !)
- b) Even slight traces of mineral oil leads to failure of the brake system. Take particular care with respect to colorless through to yellow-dyed brake fluid, since the danger of a mix-up is in this case greatest. If mineral oil is found in the brake system or there is suspicion of this being the case, thoroughly flush out the complete brake system with brake fluid. In addition, replace the main cylinder.
- c) Do not allow brake fluid to come into contact with the vehicle paintwork, since the fluid contains elements which act as solvents for paint.
- d) Brake fluid is highly hygroscopic, i.e. it absorbs moisture from the air, which lowers its boiling point. For this reason, store brake fluid only in well-sealed storage containers.

For production reasons:
continued on the following
coordinate.

Note:

During the course of the service life of brake fluid, its boiling point drops through continuous absorption of moisture from the atmosphere. In the case of very high loading of the brakes, vapor bubbles may therefore develop in the brake system.
Therefore, replace the brake fluid once a year,
preferably in Spring.

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Trouble-shooting instructions : AUD-512

BOSCH system : ABS

Vehicle make : AUDI

Basic microcard : AUD-501

Test instructions	Coordinates
Special features.....	C02
Rapid diagnosis chart.....	C02
Electrical terminal diagram, ABS until 7/84.....	C19
Electrical terminal diagram, ABS as of 8/84.....	C21
Test equipment and tools.....	C23
Installation position of components.....	C25

SPECIAL FEATURES

This microcard is for ABS testing with ABS tester ETT 016.00 (0 684 101 600) for the following vehicles:

Audi quattro, 80 quattro, 90 quattro, Coupé quattro, 100 quattro, 200 quattro as of start of production. 85 model year included.

The ABS in the Audi quattro contains 4 wheel-speed sensors and a 3-channel hydraulic modulator for front/rear split brake circuits.

The vehicles have central and rear-axle differential locks which are selectable by means of a 2-stage push-pull switch. The ABS is switched off automatically on selecting either of the locks. The driver can decide to drive either with ABS or with differential lock. By means of the push-pull switch, intake-manifold pressure is applied to a pneumatic actuator which allows the lock in the differential to take effect through an actuating lever. When the lock has been engaged, an electrical switch on the differential is mechanically actuated and switches off the power supply to the ABS.

Apart from the ABS indicator lamp, the indicator lamp for the corresponding differential lock also lights up.

RAPID DIAGNOSIS CHART FOR ABS TESTER

The following rapid diagnosis chart makes it possible for the experienced ABS expert to quickly check the ABS with the ABS tester.

If detailed instructions and information are required, use the similar detailed testing instructions SIS/AUD-501.

Before testing with the ABS tester, make sure that the following requirements are met.

REQUIREMENTS FOR TESTING WITH ABS TESTER

- * The tester must have been converted to the latest technical status (identification "U2" on nameplate or as of FD 352).
- * Check ground connection of return pump and of overvoltage-protection relay or relay set term. 31 for security and corrosion.
- * Check hydraulic connections and joints on hydraulic modulator for leaks (visual examination).
- * If, while driving, the ABS warning lamp comes on occasionally (e.g. after switching on electrical devices) and goes out again by itself, check battery and power supply (alternator, regulator and voltage drops).
- * If the ABS warning lamp is constantly on and does not go out, check the following:
 - Multiple plug correctly seated on controller and latched?
All contacts O.K.?
Spring contacts latched?
 - V-belt broken? (Alternator not supplying any power, charge indicator lamp and ABS warning lamp on).
 - Alternator term. 61 supplying power?
Plug-in connection and lead to ABS controller O.K.?
 - Perform loose-contact test on wheel-speed sensors with program switch in position 10.
- * For testing with the tester, switch on ignition for all program-switch positions (tester operates on power supply from vehicle battery).
- * Watch tester lamps 1 and 2 in all program-switch positions.

C a u t i o n !

Do not drive with tester connected.

Repeat the entire test program after each repair.

General note on trouble-shooting:

Check all leads for short circuit to ground and contact with positive leads, and watch for wearing and pinching.

* Connect ABS tester to controller and ABS wiring harness.

C a u t i o n !

Disconnect and connect controller only with ignition off.

On the Audi 80 Quattro, Audi Quattro up to 7.84, the controller is installed in the luggage compartment, rear right, behind a cover.
On all Quattro vehicles as of 8.84 it is installed under the rear seat bench on the left.

RAPID DIAGNOSIS CHART FOR ABS TESTER ETT 016.00 (0 684 101 600)

Differential locks must be off in order to maintain ABS power supply.

Program switch position	Testing of	Measure at controller terminals	Additional operation	Test specifications (Reading)	Cause of trouble
1...24	Power supply for each test step	1 (+) and 10 (-)	Switch on ignition	Lamp 1 (green) must be lit for each test step	<ul style="list-style-type: none"> * Battery unsufficiently charged. Repeat test step with engine running. * High voltage drops across terminals (e.g. ground terminal). * ABS switch-off relay, ABS step-by-step relay, overvoltage-protection relay or ABS relay set defective. * Open circuit in ground connection.
1	Valve relay - off-position	32 and 10	Switch on ignition	Lamp 1 (green) and lamp 3 (green) must be lit	<ul style="list-style-type: none"> * Open circuit or high contact resistance in leads to valve relay. * Valve relay defective.
2	Valve relay - operation	32 and 10 Negative to 27	Switch on ignition	Lamp 1 (green) and lamp 3 (green) must be lit	
3	Motor relay - off-position	14 and 10	Switch on ignition	Lamp 1 (green) and lamp 3 (green) must be lit	<ul style="list-style-type: none"> * Open circuit or high contact resistance in leads to motor relay. * Motor relay defective. * Check pump motor for continuity.
4	Motor relay - operation	14 and 10 Negative to 28	Switch on ignition Press illuminated key	Lamp 1 (green) and lamp 3 (green) must be lit	

Program switch position	Testing of	Measure at controller terminals	Additional operation	Test specifications (Reading)	Cause of trouble
5	Fuse and uni-directional-breakdown diode in over-voltage-protection relay or relay set (under test is the relay which is plugged into the test plug on the tester).	1 and 10	Ignition off. Disconnect controller. Plug relay from vehicle into test plug on back of tester using adapter lead. Plug new relay into vehicle. Switch on ignition; wait approx 1 sec., then press illuminated key. After testing, switch off ignition and re-connect controller.	Lamp 1 (green) must be constantly lit. After pressing illuminated key, lamp 3 (green) must light up.	* The relay in the socket on the tester is defective.
6	Internal resistances of solenoid-op. valves in hydraulic modulator	2 and 32 35 and 32 18 and 32	Ignition on. Press key FL Press key FR Press key RA	Lamp 1 (green) must be constantly lit FL: 0,7...1,7 Ω FR: 0,7...1,7 Ω RA: 0,7...1,7 Ω	* Open circuit or high contact resistance in leads to respective valve * Hydraulic modulator defective.
7	Ground connection to terminal 10	10	Ignition on. Press illuminated key.	Lamp 1 (green) must be constantly lit 80...300 mV	* Open circuit or high contact resistance in ground lead and ground terminal.
8	Ground connection to terminal 34	34	Ignition on. Press illuminated key.	Lamp 1 (green) must be constantly lit 30...250 mV	
9	Ground connection to terminal 20	20	Ignition on. Press illuminated key.	Lamp 1 (green) must be constantly lit. 30...250 mV	

Program switch position	Testing of	Measure at controller terminals	Additional operation	Test specifications (Reading)	Cause of trouble
10	Internal resistances of wheel-speed sensors	4 and 22 21 and 23 7 and 9 24 and 26	Ignition on. Press key FL Press key FR Press key RL Press key RR	Lamp 1(green) must be constantly lit 0,8...1,8 k Ω 0,8...1,8 k Ω 0,8...1,8 k Ω 0,8...1,8 k Ω	* Check for loose contacts: Move all leads at fastening points, at plug and at wheel-speed sensor and watch reading. * Open circuit or high contact resistance in leads to the respective wheel-speed sensor. * Respective wheel-speed sensor defective.
11	Insulation resistances of wheel-speed sensors	22 and 10 23 and 10 9 and 10 26 und 10	Ignition on. Press key FL Press key FR Press key RL Press key RR	Lamp 1 (green) must be constantly lit 20...999 k Ω 20...999 k Ω 20...999 k Ω 20...999 k Ω	* Check leads to respective wheel-speed sensor for insulation damage. * Respective wheel-speed sensor defective.
12	DC voltage on wheel-speed sensor leads	22 and 10 23 and 10 9 and 10 26 and 10	Ignition on Press key FL Press key FR Press key RL Press key RR	Lamp 1 (green) must be constantly lit 000...100 m V 000...100 m V 000...100 m V 000...100 m V	* Check leads to respective-wheel sensor for contact (worn spot) with a positive lead. * Respective wheel-speed sensor defective.
13	Controller-internal supply voltage	12 and 10	Ignition on. Press illuminated key:	Lamp 1 (green) must be constantly lit. 4,75...5,25 V	* Controller defective.
14	Diode (in hydraulic modulator) in forward direction and ABS warning lamp	29 and 32	Ignition on.	0,4...1,5 V ABS warning lamp in vehicle must light up.	* Open circuit or high contact resistance in leads to diode/indicator lamp. * Indicator lamp defective. * Diode (hydraulic modulator) defective.

Program switch position	Testing of	Measure at controller terminals	Additional operation	Test specifications (Reading)	Cause of trouble
15	Diode (in hydraulic modulator) in reverse direction	29 and 32 Negative to 29	Ignition on	2,5...8,5 V ABS warning lamp slightly dimmer	* Diode (hydraulic modulator) defective.
16	Controller, BITE (built-in test equipment) triggering	29 and B +	Ignition on. Press illuminated key for min. 3 sec.:	ABS warning lamp must go out after max. 1 sec.	* Controller defective.
17	Controller, BITE fault simulation	29 and B +	Ignition on. Press illuminated key for min. 3 sec.:	ABS warning lamp must be constantly lit (flickering after approx 1 sec. allowable).	* Controller defective.
18	Not applicable				
19	Controller, current for pressure reduction	2 35 18	Ignition on. Press key FL. Press illuminated key: Press key FR Press illuminated key: Press key RA Press illuminated key:	FL : 4,5...6,0 A FR : 4,5...6,0 A RA : 4,5...6,0 A	* Controller defective.
24	Voltage from stop-lamp switch	25 and 10	Ignition on. Press brake pedal.	10...15 V	* Lead to stop-lamp switch defective. * Stop-lamp switch defective. * Stop lamps defective.

A dynamic brake analyzer is required for program-switch positions 20, 21, 22 and 23.
 Do not drive with tester connected.
 Do not use a brake-pedal actuating device for setting the braking force.
 Program-switch position 23 must come first.
 Front axle: Drive front wheels of vehicle onto dynamic brake analyzer.
 Pull on handbrake.

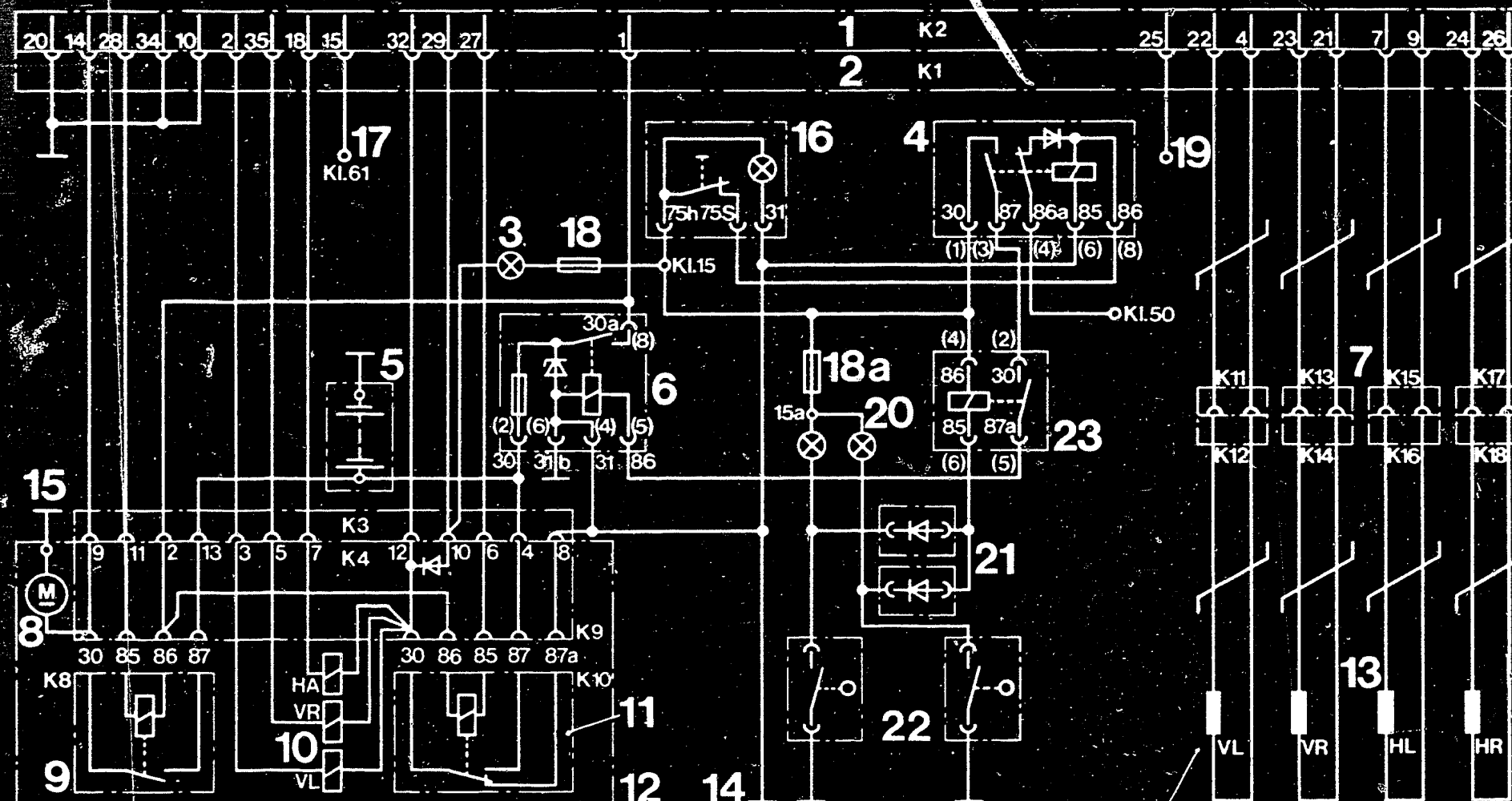
Program switch position	Testing of	Measure at controller terminals	Additional operation	Test specifications (Reading)	Cause of trouble
23	Wheel-speed sensor signal. Identity check	22 and 4	Press key FL. Switch on left-hand brake roller.	FL : 1,7...19	* Wheel-speed sensors mixed up? * Air gap too big. * Respective wheel-speed sensor defective.
		23 and 21	Press key FR. Switch off left-hand brake roller; switch on right-hand brake roller.	FR : 1,7...19	
20	Hydraulic modulator Pressure reduction Identity check	Current supply to term. 35	Press key FR. Switch on right-hand brake roller. Press brake pedal and hold constant at 2000 N. Press illuminated key.	FR: < 1100 N	* Brake lines mixed up? * Conventional braking system O.K.? * Hydraulic modulator defective. N o t e: Replace hydraulic modulator as a complete unit only. Repair not allowed. D a n g e r !
		Current supply to term. 2	Press key FL. Switch off right-hand brake roller. Switch on left-hand brake roller. Hold constant at 2000 N with brake pedal. Press illuminated key.	FL: < 1100 N	
21	Hydraulic modulator Pressure build-up	Current supply to term. 2	Press key FL. Switch on both brake rollers, press brake pedal and hold constant at 2000 N. Press illuminated key.	Left-hand reading on dynamic brake analyzer moves to an intermediate value and rises again to FL: 600...1500 N	

Program switch position	Testing of	Measure at controller terminals	Additional operation	Test specifications (Reading)	Cause of trouble
21	Hydraulic modulator Pressure build-up	Current supply to term. 35	Press key FR. Switch on both brake rollers. Press brake pedal and hold constant at 2000 N. Press illuminated key.	Right-hand reading on dynamic brake analyzer moves to an intermediate value and rises again to FR : 600...1500 N	* Brake lines mixed up? * Conventional braking system O.K.? * Hydraulic modulator defective. N o t e : Replace hydraulic modulator as a complete unit only. Repair not allowed. D a n g e r !
22	Hydraulic modulator Pump delivery brake circuit 1	Current supply to term. 35	Switch on brake rollers. Read off right-hand inherent-friction value. Press key FR. Press brake pedal and hold constant at 2000 N. Press illuminated key.	After an intermediate reading on right, return pump cuts in briefly. Right-hand reading must drop below inherent-friction value plus 200 N Reading appears only briefly.	* Hydraulic modulator defective. N o t e : Replace hydraulic modulator as a complete unit only. Repair not allowed. D a n g e r !

Rear axle: Drive wheels of vehicle onto dynamic brake analyzer.
Release handbrake.

Program switch position	Testing of	Measure at controller terminals	Additional operation	Test specifications (Reading)	Cause of trouble
23	Wheel-speed sensor signal and identity check	7 and 9	Press key RL. Switch on left-hand brake roller.	RL: 1,7...19	<ul style="list-style-type: none"> * Wheel-speed sensors mixed up? * Air gap too big. * Respective wheel-speed sensor defective.
		24 and 26	Press key RR. Switch off left-hand brake roller. Switch on right-hand brake roller.	RR: 1,7...19	
20	Hydraulic modulator Pressure reduction	Current supply to term. 18	Press key RA. Switch on both brake rollers. Press brake pedal and hold constant at 1500 N. Press illuminated key.	RA: <900 N	<ul style="list-style-type: none"> * Brake lines mixed up? * Conventional braking system O.K.? * Hydraulic modulator defective. <p>N o t e : Replace hydraulic modulator as a complete unit only. Repair not allowed. D a n g e r !</p>
21	Hydraulic modulator Pressure build-up	Current supply to term. 18	Press key RA. Switch on both brake rollers. Press brake pedal and hold constant at 1500 N. Press illuminated key.	Readings on both sides of dynamic brake analyzer move to intermediate values and rise again to RA: 400...1000 N	
22	Hydraulic modulator Pump delivery brake circuit 2	Current supply to term. 18	Switch on brake rollers. Read off inherent-friction value. Press key RA. Press brake pedal and hold constant at 1500 N.	After an intermediate reading on both sides, return pump cuts in briefly. Readings on both sides must drop below inherent-friction value plus 200 N Reading appears only briefly.	<ul style="list-style-type: none"> * Hydraulic modulator defective. <p>N o t e : Replace hydraulic modulator as a complete unit only. Repair not allowed. D a n g e r !</p>

Finally, perform a road test. With the engine running, warning lamp must go out. Drive at at least 30 km/h. Warning lamp must not come on again.



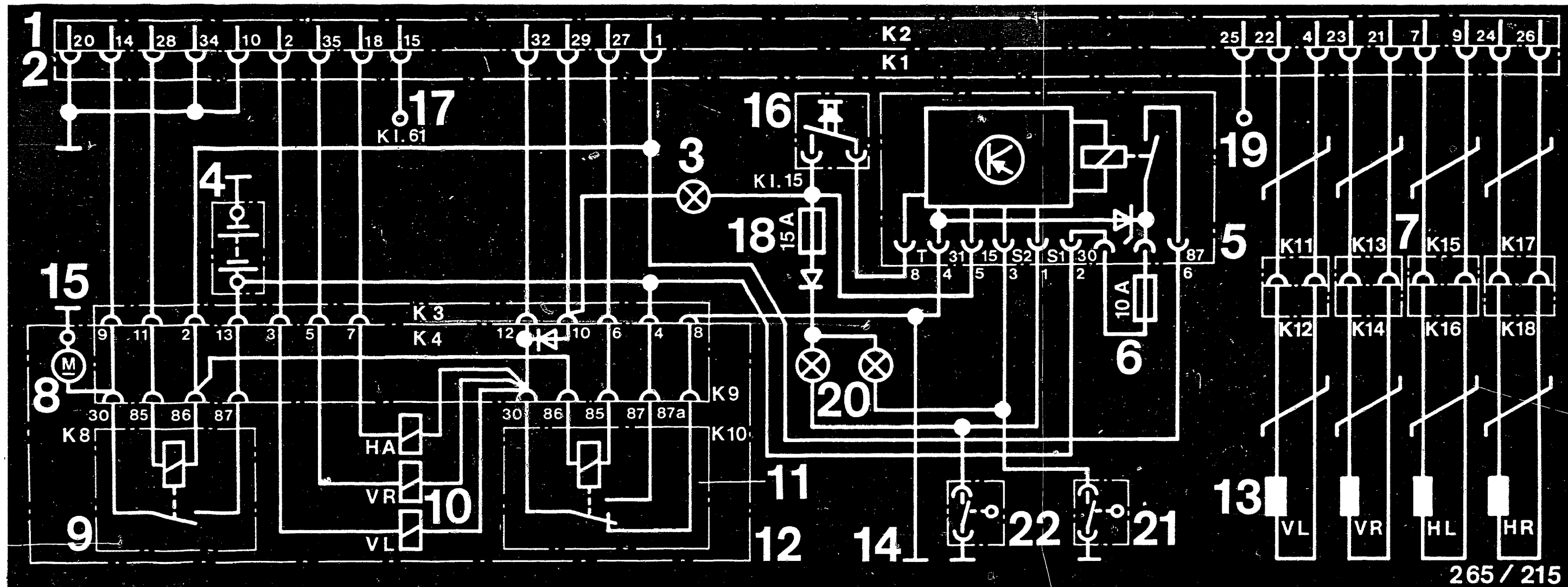
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- 1 = Electronic controller
- 2 = Multiple plug (35-pin)
- 3 = ABS warning lamp
- 4 = Relay for controller (step-by-step relay)
- 5 = Battery
- 6 = Overvoltage-protection relay
- 7 = Cable connector
- 8 = Return-pump motor
- 9 = Motor relay
- 10 = Solenoid-operated valves
- 11 = Valve relay
- 12 = Hydraulic modulator
- 13 = Wheel-speed sensor
- 14 = Ground terminal behind dashboard
- 15 = Ground terminal, eng. comp. left
- 16 = ABS switch
- 17 = to alternator

- 18 = Fuse in relay board with fuse holder
- 18a = Fuse No. 12 (15A) in central-electrics box
- 19 = to stop-lamp switch
- 20 = Indicator lamps for differential locks
- 21 = Diode plug
- 22 = Switch for differential locks
- 23 = ABS switch-off relay

- VL = FL = front left
- VR = FR = front right
- HL = RL = rear left
- HR = RR = rear right
- HA = RA = rear axle
- K1, K2
- etc. = Plug numbers

ABS ELECTRICAL TERMINAL DIAGRAM up to 7/84 date of manufacture



- 1 = Electronic controller
- 2 = Multiple plug (35-pin)
- 3 = ABS warning lamp
- 4 = Battery
- 5 = Relay set
- 6 = Plug-in fuse (10A) in relay set
- 7 = Cable connector
- 8 = Return-pump motor
- 9 = Motor relay
- 10 = Solenoid-operated valves
- 11 = Valve relay
- 12 = Hydraulic modulator
- 13 = Wheel-speed sensor
- 14 = Ground terminal behind dashboard
- 15 = Ground terminal, eng. comp. left
- 16 = ABS switch

- 17 = to alternator
- 18 = Fuse No. 12 (15 A) in central-electrics box
- 19 = to stop-lamp switch
- 20 = Indicator lamps for differential lock
- 21 = Switch for differential lock (rear)
- 22 = Switch for differential lock (central)

- VL = FL = front left
- VR = FR = front right
- HL = RL = rear left
- HR = RR = rear right
- HA = RA = rear axle
- K1, K2
etc. = Plug numbers

ABS ELECTRICAL TERMINAL DIAGRAM as of 8/84 date of manufacture

TEST EQUIPMENT AND TOOLS

Description	Designation	Part Number
ABS tester Use only converted testers. Identification "U2" on nameplate or as of FD 352	ETT 016.00	0 684 101 600
Adapter cable for connection of overvoltage-protection relay or relay set		1 684 460 120
Dynamic brake analyzer	e.g. BPS 100 or BPS 101 or BPS 104 or BPS 105	0 680 012 .. 0 680 013 .. 0 680 018 .. 0 680 019 ..
Charging and bleeding device		e.g. ATE part number 3.9302-1000.4 1)
Bleeder fitting For connecting the charging and bleeding device to the master-cylinder brake-fluid reservoir		ATE Part No. 3.9302.0702.2 1)
Bleeder hose		ATE Part No. 3.3590.2300.1 1)
Auxiliary hose		ATE Part No. 3.9302.0704.2 1)
Brake-pedal actuating device		ATE Part No. 3.9312.0100.4 1)

1) Obtainable from: Alfred Teves GmbH, Guerickestr. 7,
D-6000 Frankfurt (Main).

Test equipment and tools (continued)

Description	Designation	Part Number
Pressure tester Tester for low- and high-pressure testing of hydraulic braking systems		e.g. ATE Part No. 3.9305-0200.4 1)
Double-end box wrench, open 9 x 11 mm		Hazet Part No. 612 2)
Vessel for catching the brake fluid approx 1 l		
Brake fluid Use only ATE genuine brake fluid DOT4 or VW brake fluid.		
Electrics tester or multimeter for trouble-shooting	ETE 014.00	0 684 101 400 commercially available
Grease for wheel-speed sensors		Molykote Longterm 2
Protective caps for brake lines		1 900 508 002 (100 pieces)
Protective caps for brake-line connections on hydraulic modulator		1 900 508 004 (100 pieces)
Use only genuine VW brake lines.		

1) Obtainable from:
Alfred Teves GmbH Guerickestr. 7
D-6000 Frankfurt (Main)

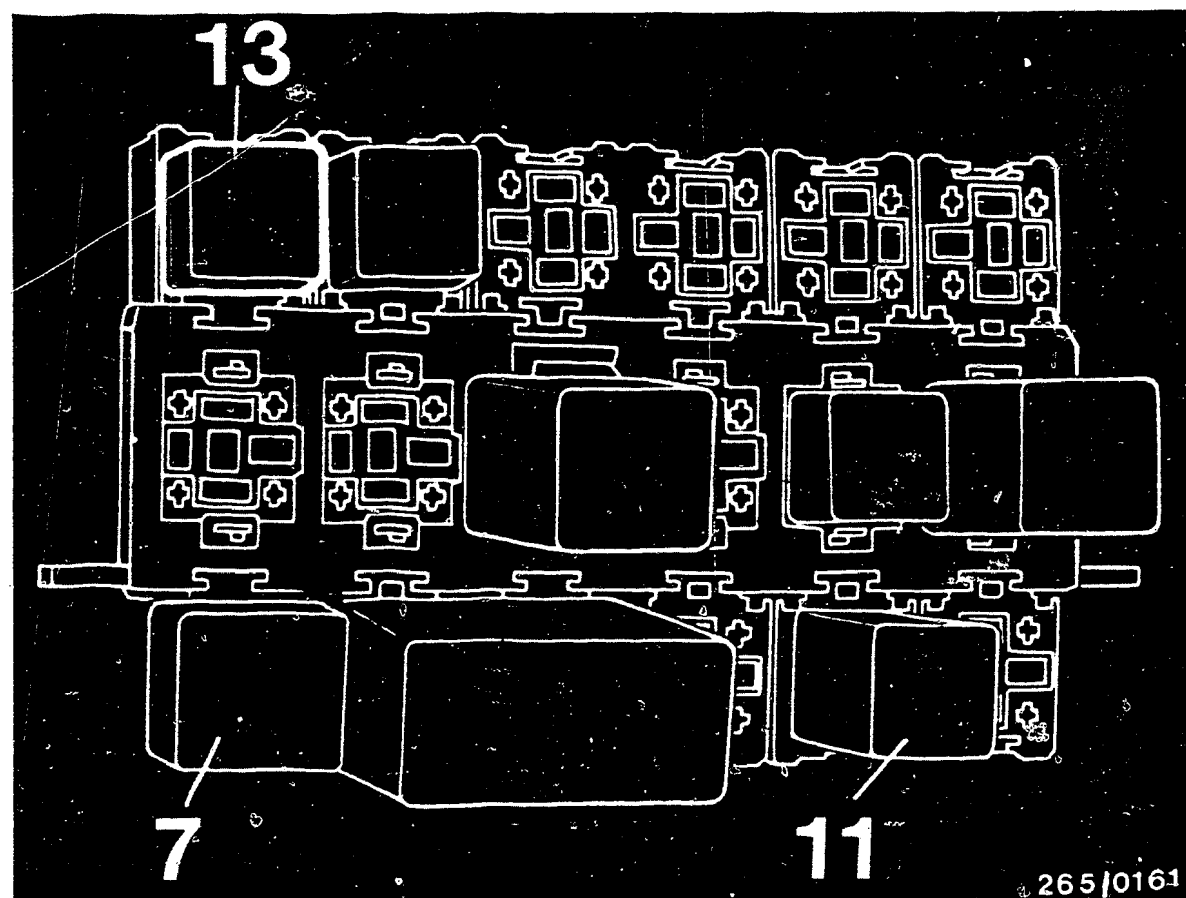
2) Obtainable from: Hazet D-5630 Remscheid

INSTALLATION POSITION OF COMPONENTS

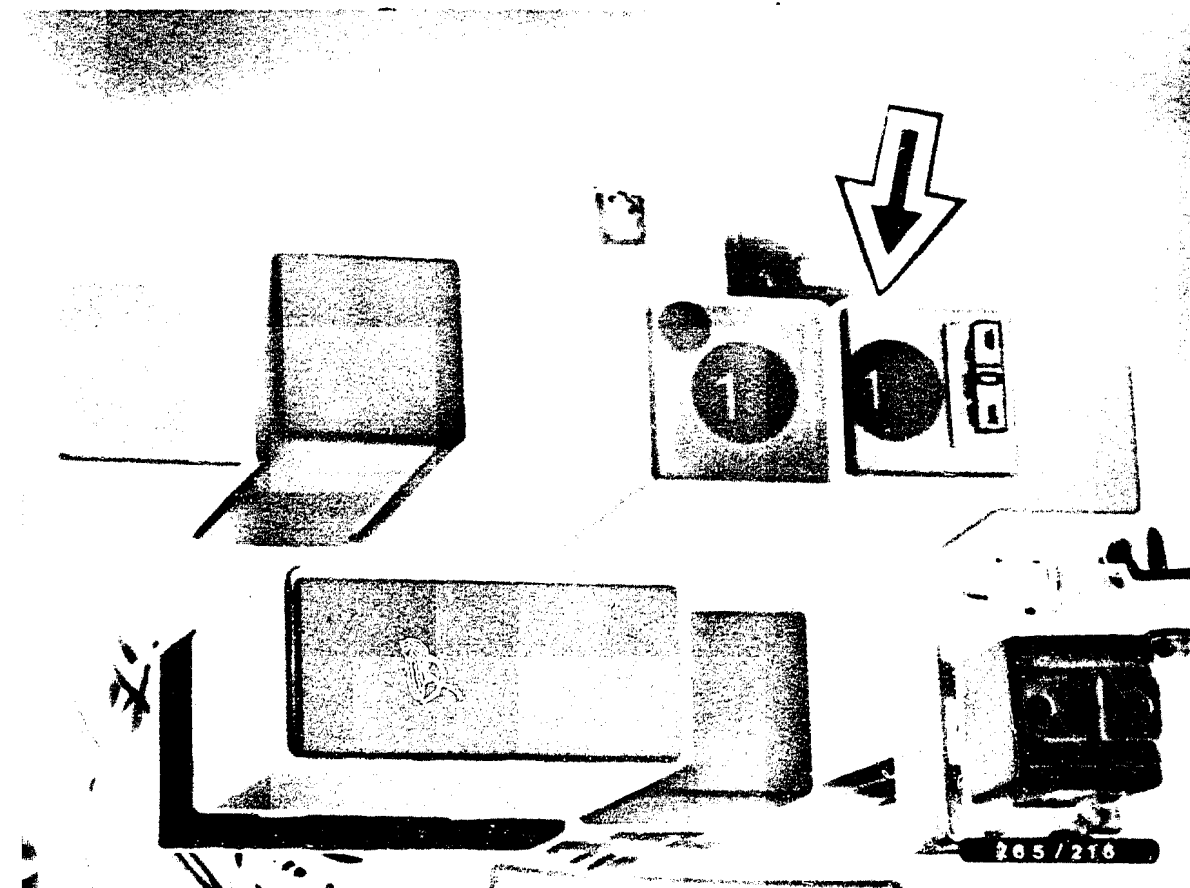
The indications "right" and "left" apply always as viewed in the forward direction of travel.

- * ABS indicator lamp:
In instrument panel.
- * ABS switch:
In instrument panel.
- * Front-axle wheel-speed sensors:
One each on left and right in steering knuckles.
- * Rear-axle wheel-speed sensors:
One each on left and right near the brake calipers.
- * Hydraulic modulator:
In engine compartment on left in front of brake master cylinder.
- * Ground terminal for ABS:
On hydraulic modulator mounting.
- * Controller:
Audi 80 Quattro, Audi Quattro up to 7.84:
In luggage compartment, rear right, behind a cover.
All Quattro vehicles as of 8.84:
Under rear seat bench on left.
- * Switches for differential locks:
One each in housings for central and rear-axle differential locks.
- * Diode plug:
Under instrument panel, near relay support.
Not applicable if relay set installed.

For production reasons:
continued on the following
coordinate.



- * Relay for controller (step-by-step relay) up to 7.84:
Under instrument panel on left in relay support, relay location 7.
- * Overvoltage-protection relay up to 7.84:
Under instrument panel on left in relay support, relay location 11.
- * ABS switch-off relay for differential lock up to 7.84:
Under instrument panel on left in relay support, relay location 13.



- * Relay set as of 8.84:
Under the instrument panel on the right in the relay support (see picture, arrow).

T A B L E O F C O N T E N T S

Trouble-shooting instructions : FER-501
BOSCH System : ABS

Vehicle make : Ferrari
Basic microcard : KFZ-00..

SPECIAL FEATURES

This microcard contains the ABS Trouble-Shooting Instructions, for the following model applicable at the time of publication:

Ferrari 412 1 as of 9.85

Test instructions	Coordinates
Special features.....	F02
Test specifications / requirements for testing.....	F03
Rapid diagnosis chart.....	F05
Electrical terminal diagram.....	F17
Tools and test equipment.....	F19
Installation position of components.....	F21
General information.....	F24

TEST SPECIFICATIONS

For reasons of safety, the ABS must be tested only with the ABS tester. The rapid diagnosis chart contains all the important test specifications together with instructions for testing and trouble-shooting.

TEST REQUIREMENTS FOR TESTING WITH ABS

2 LED TESTER

- * Regulatory tire size fitted?
- * Check for firm seating and corrosion of ground of return-supply pump and of over-voltage protection relay term.31.
- * Check for leaks in hydraulic connections and sealing points at hydraulic modulator (visual examination).
- * If the ABS warning lamp lights up intermittently when driving (e.g. after switching on consuming devices) and goes out again by itself, check the battery and power supply (generator, regulator and voltage drops).
- * If the ABS warning lamp lights up constantly and does not go out, check the following points:
 - Multipole plug sitting correctly on controller and latched?
 - All plug contacts O.K.?
 - Spring contacts latched?
 - Check installation position for correct seating of seal ring in controller plug: rounded side downwards.

- Check for correct assignment of wheel-speed-sensor leads at controller plug.

Wheel-speed sensor
front left to term.6 and term.4.
Wheel-speed sensor
front right to term.11 and term.21.
Wheel-speed sensor
rear left to term.8 and term.9.

- V-belt snapped?
(Generator provides no voltage, charge-indicator lamp and ABS warning lamp light up).
- * For checking, switch on ignition to all program-selector-switch positions (tester operates with current supply from vehicle battery).
- * Observe LED (green) for current supply in all program-selector-switch positions.
- * Connect ABS 2 LED tester to ABS wiring harness.

C A U T I O N !

Disconnect and connect controller only with ignition switched off.
Do not run with tester connected!
Repeat the complete test program after each repair.
The Antiskid System is a vehicle safety system.
Work on this system demands detailed knowledge of the system.
The conventional brake system must be O.K.

General information for trouble-shooting:

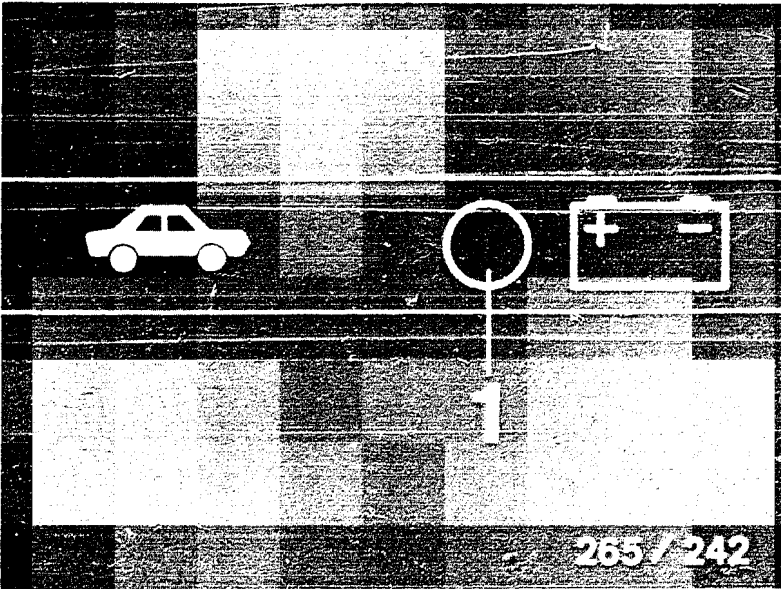
Check all leads for short circuit to ground and contact with positive lines and watch out for rubbed and pinched locations.

Rapid diagnosis chart

Do not run with tester connected! Are all test requirements complied with?

Program-selector-switch position 1 to 6

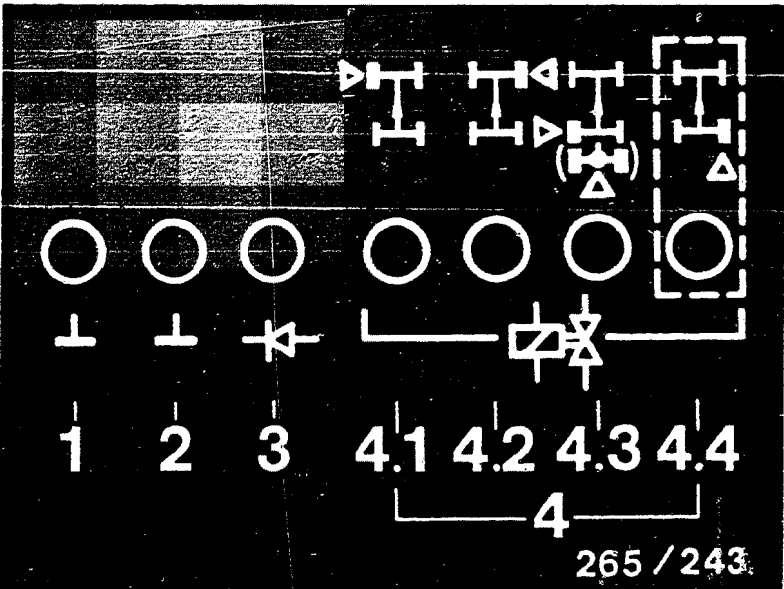
Test on (measurement at terminals)	Additional operation	Test specifi- cation (reading)	Possible causes of trouble (see coordinates)
Power supply (term. 1 and term. 20)	Ignition on	LED 1 (Upper illust- ration) Lights up continuously	*Fuse defective (—) *Battery insufficiently charged *Voltage drops too high (—) *Over-voltage protection relay defective (—) *Check lead to driving switch term. 15



Rapid diagnosis chart (Continuation 1)

Program-selector-switch position 1 (3-channel hydraulic modulator)

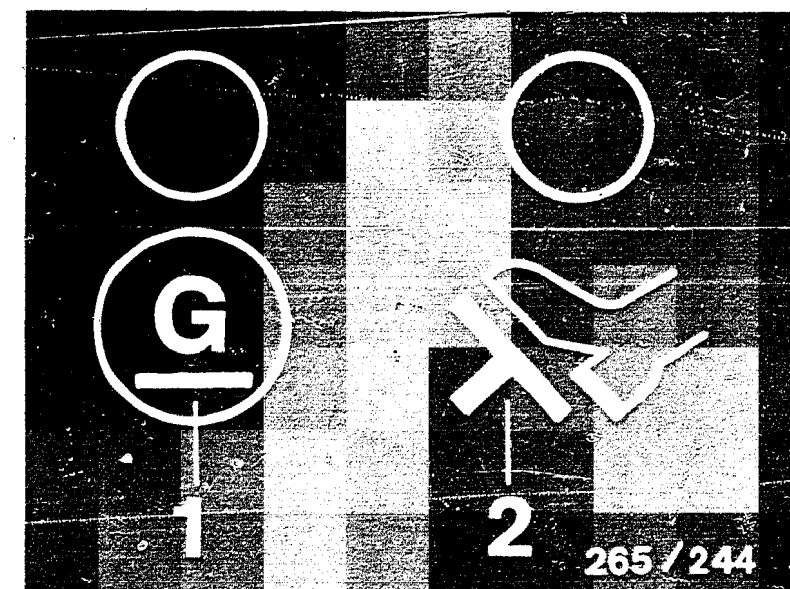
Test on (measurement at terminals)	Additional operation	Test speci- fication (reading)	Possible causes of trouble (see coordinate)
Ground (term.10, term.4.3) Diode for warning lamp (term.29, term.32) Solenoid-operated valve – internal resistances (term.18, term.—, term.35) Off-position and ground of valve relay ABS warning lamp	Ignition on	6 LED (34 to 1) light up equally brightly (upper illu- stration) ABS warning lamp in vehicle must light up	<p>* LED 1 and / or 2 (upper illustration) do not light up: Check ground terminals for short circuit. (—)</p> <p>* LED 3 (upper illustration) does not light up: Diode defective, check ground of valve relay. (2)</p> <p>* One or more LED 4 do not light up: Check corresponding plug connection for solenoid-operated valve and leads. (—)</p> <p>Solenoid-operated valve, internal resistance 0,7...1,7 Ω</p> <p>* All LED 4 and LED 3 do not light up: Check ground of valve relay, valve relay defective. (—)</p> <p>* Weak lighting of a LED means contact resistance in corresponding current path. (—)</p> <p>ABS warning lamp does not light up: Warning lamp defective. <u>Note:</u> All other 6 LEDs light up (—)</p>



Rapid diagnosis chart (Continuation 2)

Program-selector-switch position 2

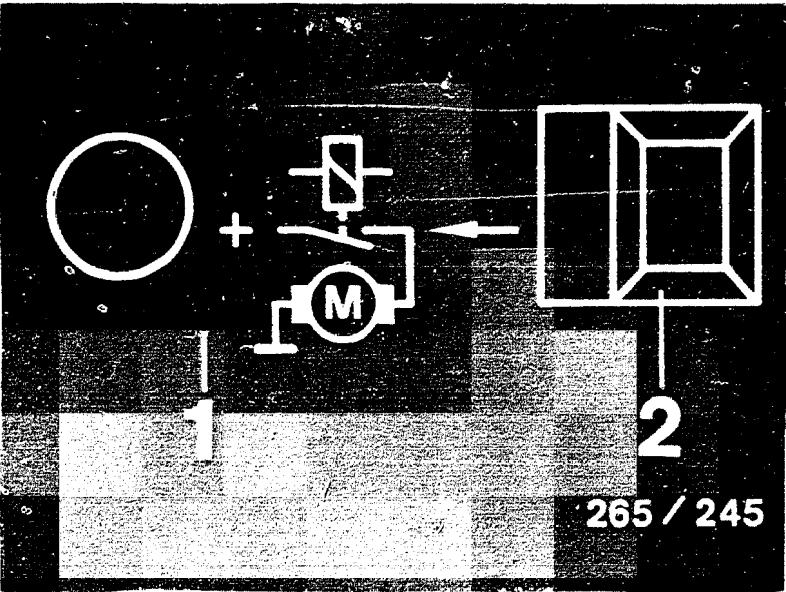
Test on (measurement at terminals)	Additional operation	Test specifi- cation (reading)	Possible causes of trouble (see coordinate)
Generator voltage of term. 61 (term. 15)	Ignition on	LED 1 (upper illus- tration) lights up.	<ul style="list-style-type: none"> * LED 1 sometimes goes out only after snap acceleration (test is then O.K.) (—) * Check line to generator term. 61 * Generator defective
	Start engine	LED 1 (upper illus- tration) goes out with engine running	
Stop-lamp switch (term. —)	Ignition on	LED 2 (upper illus- tration) lights up	<ul style="list-style-type: none"> * Check lead to stop-lamp switch. (25) * Stop-lamp switch defective * Lead at stop-lamp switch incorrectly connected
	Actuate brake pedal	LED 2 (upper illus- tration) goes out	



Rapid diagnosis chart (Continued 3)

Program-selector-switch position 3

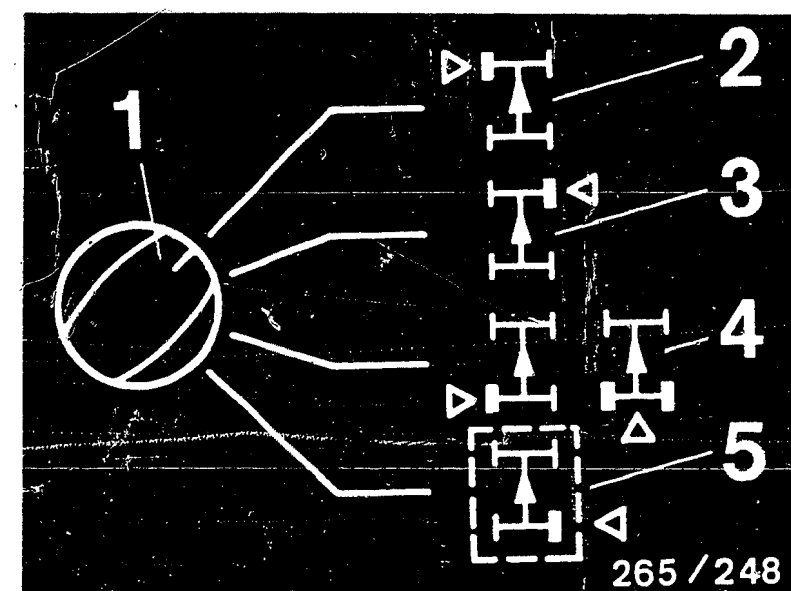
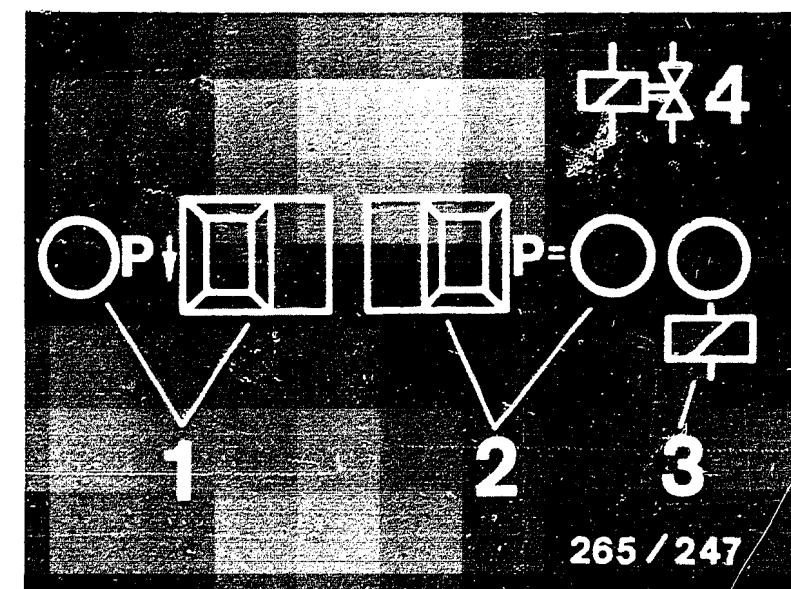
Test on (measurement at terminals)	Additional operation	Test specifi- cation (reading)	Possible causes of trouble (see coordinate)
Motor relay, Pump motor in hydraulic modulator (term.28 and term.14)	Ignition on, constantly press push- button 2 (upper il- lustration)	LED 1 lights up, pump motor runs. After releasing push-button, LED stays lit due to run-on of motor armature (upper illus- tration)	<ul style="list-style-type: none">* Motor relay defective (—)* Check ground and positive terminal of hydraulic modulator (—)* Check leads from controller term.14 and term.28 to hydraulic modulator term.9 or term.11. (—)* Pump motor defective (—)



Program-selector switch position 4 not applicable

Rapid diagnosis chart (Continuation 4)
Program-selector-switch position 5 (3 channel hydraulic modulator)

Test on (measurement at terminals)	Additional operation	Test specifi- cation (reading)	Possible causes of trouble (see coordinate)
Valve relay operation (term.27)	Ignition on	LED 3 (upper illustration) lights up	Valve relay (winding) or leads defective (—)
Solenoid-operated valves in hydraulic modul- ator for function and mix-up. NOTE: Check each wheel seperately in turn. Keep to operating sequence	Chock up vehicle. Ignition on. The wheel being tested must be freely turnable by hand. Set Switch 1 for wheel selection to wheel to be tested. (Lower illus- tration)		<ul style="list-style-type: none"> * Repeat test with engine running * Valve relay (make contact) defective (—) * Break in line from valve relay term. 87 to B+ (—) * Brake leads at hydraulic modulator mixed up (—) * Current value not obtained (LED P arrow or P= go out; upper illustration): Battery insufficiently charged. Repeat check with engine running. (—) * Solenoid-operated valves correctly connected electrically? Wheel, front left: term.2 Wheel, front right: term.35 Wheel, rear left: term.— Wheel, rear right: term.— Rear axle: term.18 (—) * Hydraulic modulator defective(—)
Operation pressure holding	1. Constantly press push-button P= (upper illust.) 2. Constantly press brake pedal	LED P= (upper illus- tration) lights up Wheel turnable by hand	
	3. Release push-button P= (upper illus- tration)	LED P= goes out (upper illus- tration) Wheel locks	
Operation pressure reduction	4. Press push-button P arrow (upper illus- tration)	LED P arrow (upper illus- tration)lights up, wheel turnable by hand	
	5.Release push-button P arrow (upper illus- tration)	LED P arrow (upper illus- tration) goes out, wheel locks	
	6.Release brake pedal		

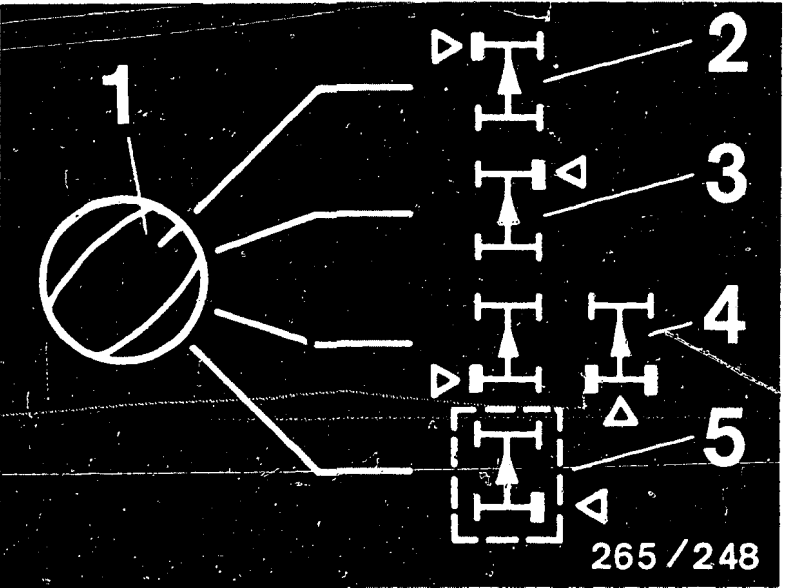
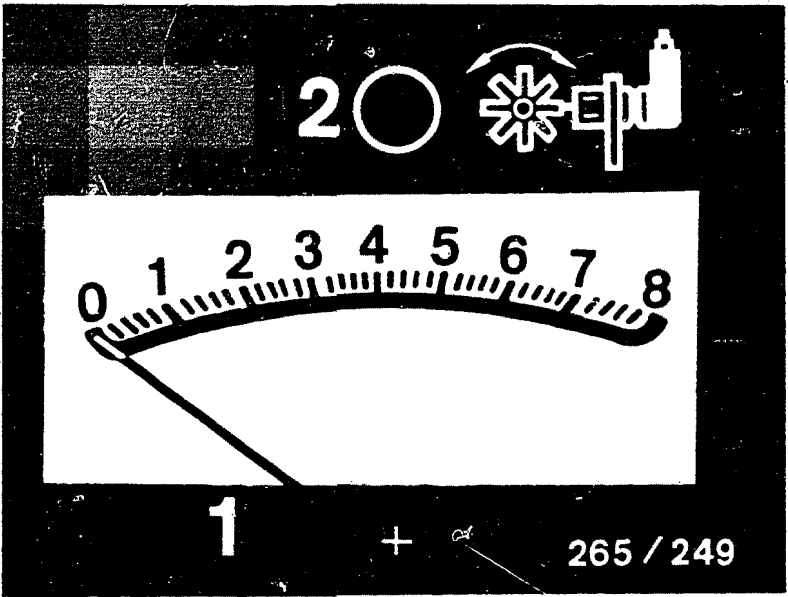


Rapid diagnosis chart (Continuation 5)

Program-selector-switch position 6 (4 wheel-speed sensors)

Test on (Measurement at terminals)	Additional operation	Test specification (reading)	Possible causes of trouble (see coordinate)
<p>Wheel-speed sensor for operation and mix-up</p> <p>NOTE: Check each wheel separately in turn.</p> <p>(Wheel, front left: term.4 and term.0,6...1,6) Wheel, front right: term.11 and term.21) Wheel, rear left: term.8 and term.—) Wheel, rear right: term.24 and term.—</p>	<p>Chock up vehicle. Ignition on.</p> <p>The wheel being tested must be freely turn- able by hand.</p> <p>When testing the driven axle, the wheel not being tested must be locked.</p> <p>Set switch for wheel selection to wheel to be tested (lower illustration)</p> <p>Turn wheel by hand until LED 2 above instrument lights up without flickering. (Wheel speed approx. 1 revolution per second). Afterwards, read off indication at instru- ment: (upper illustration)</p>	<p>1.Smallest reading larger 1,6 divisions</p> <p>2.Permissible fluctuation max.0,6...1,6 from largest reading.</p>	<p>*Wheel-speed-sensor lead mixed up (—)</p> <p>*Break in wheel-speed- sensor lead (—)</p> <p>*Wheel-speed sensor defective(—) Winding resistance Front axle: 25 k Ω Rear axle: 6 k Ω</p> <p>*Air gap between wheel- speed sensor and ring gear too wide (9)</p> <p>*Ring gear defective or loose (26)</p> <p>*Ring gear with incor- rect number of teeth installed Front axle: 48 teeth Rear axle: 48 teeth (—)</p> <p>*Wheel-bearing clearance too large</p>

Take for road test for final check. With the engine running, the warning lamp must go out. Drive at at least 30 km/h. The warning lamp must not light up again!



TEST EQUIPMENT AND TOOLS

Designation	Code	Part number
ABS2 LED tester	KDAS 0003	Procure. address: Robert Bosch GmbH KH/VKD 3 Postfach 41 09 60 7500 Karlsruhe 41
Adapter lead (included in scope of delivery of tester)	KDAS 0003/2	
Charging and bleeding device		e.g. ATE Part No. 3.9302-1000.4 1)
Bleeder fitting for connection of charging and bleeding device to fluid reservoir of brake master cylinder		ATE Part No. 3.9302.0702.2 1)
Bleeder hose		ATE Part No. 3.3590.2300.1 1)
Auxiliary hose		ATE Part No. 3.9302.0704.2 1)
Brake-pedal-actuating device		ATE Part No. 3.9312.0100.4 1)

1) = obtainable from: Alfred Teves GmbH,
Guerickestr. 7
D-6000 Frankfurt (Main)

Test equipment and tools (continued)

Designation	Code	Part number
Pressure tester Tester for checking low- pressure and high- pressure at hydraulic brake systems		e.g., ATE Part No. 3.9305-0200.4 1)
Flat double-end flare nut wrench, 9 x 11 mm		Hazet Part No. 612 2)
Container, approx. 1l for catching the brake fluid		
Brake fluid Use only DOT 4 or brake fluid from the vehicle manu- facturer.		
Electrics tester or multimeter for trouble- shooting	ETE 014.00	0 684 101 400 commercially available

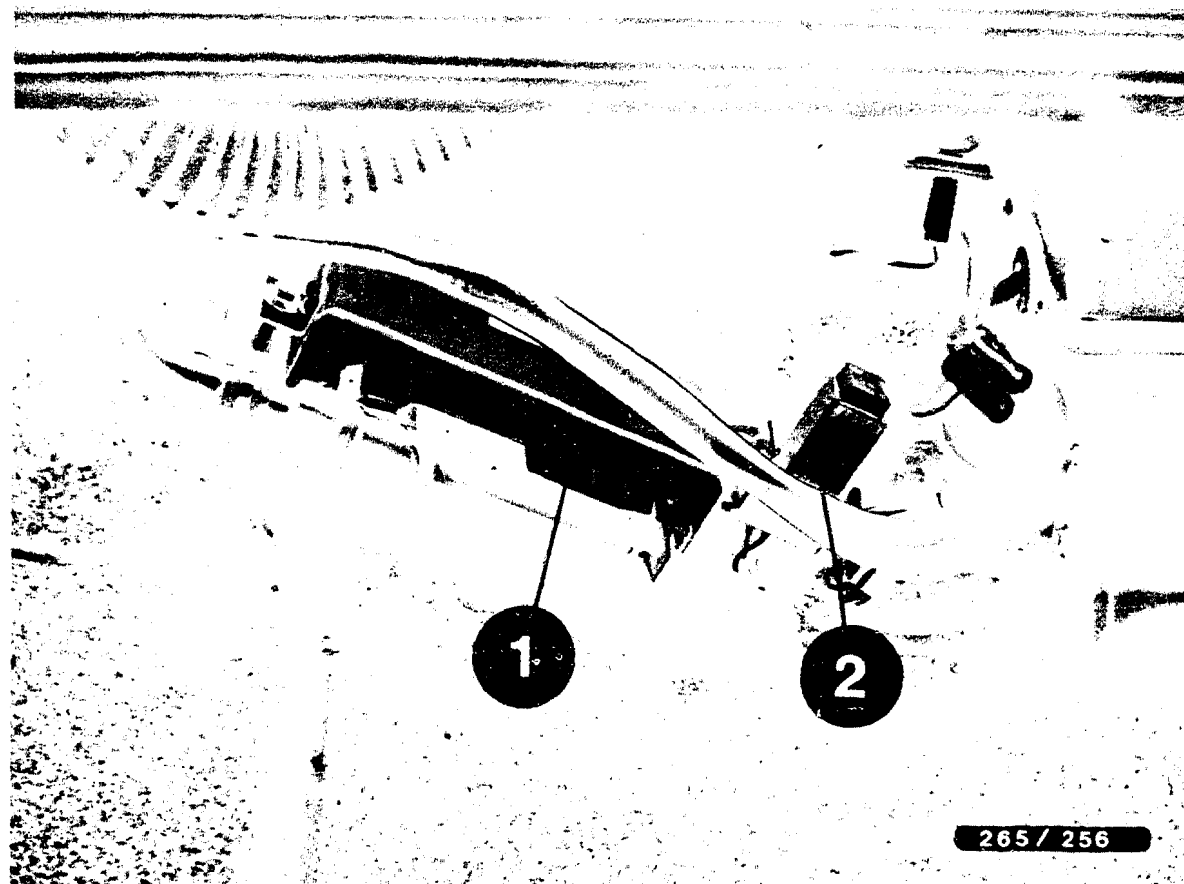
Aids!

Use only original brake lines from the vehicle manu-
facturer!

Grease for wheel-speed sensor	Molykote Longterm 2
Protective caps for brake lines	1 900 508 002 (100 pieces)
Protective caps for brake-line connections at hydraulic modulator	1 900 508 004 (100 pieces)

1) obtainable from: Alfred Teves GmbH Guerickestr. 7
D-6000 Frankfurt (Main)

2) obtainable from: Hazet Co, D-5630 Remscheid



INSTALLATION POSITION OF COMPONENTS

Details of the installation position are always with reference to the forward direction of travel.

1 = Controller:
In the luggage compartment

2 = Over-voltage protection relay:
To the right of the controller in the luggage compartment

ABS warning lamp:
In instrument panel

ABS ground terminal:
Under the vehicle between the differential and fuel tank at the transverse member.



1 = Wheel-speed sensor, front right.
Take care that the wheel-speed sensors of the front wheels are not swapped between left and right during installation. Signal becomes too small!

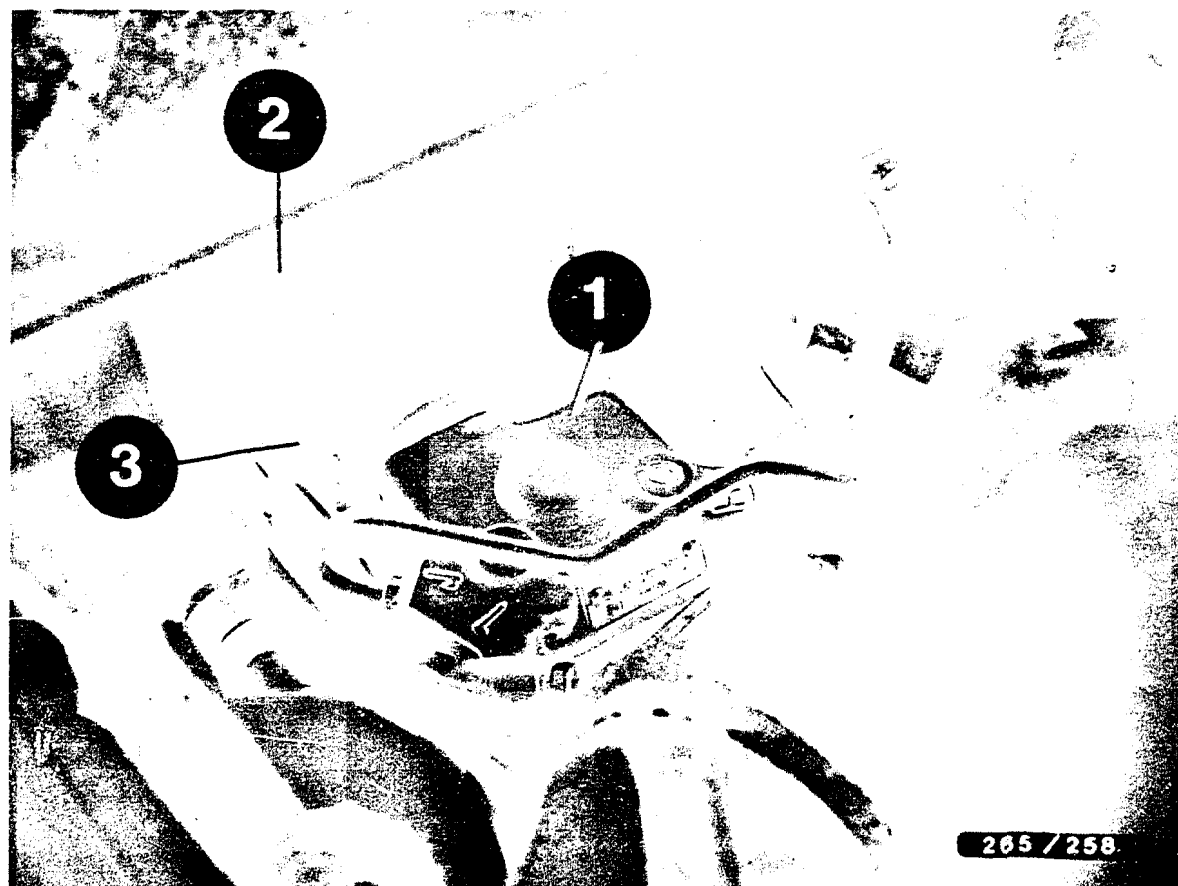
Arrow = Fastening points of the wheel-speed-sensor lead

* Wheel-speed sensors, front axle:

One on both sides in the steering knuckles. Plug connections are underneath the vehicle to the left and right of the oil pan at the transverse member.

* Wheel-speed sensors, rear axle:

One on both sides next to the McPherson struts. Plug connections are underneath the vehicle between the differential and fuel tank at the transverse member. Caution! Do not mix up plug connections. Observe coding, L (left) and R (right)!



- 1 = Hydraulic modulator :
In the engine compartment, under the left headlamp.
- l = Brake line to wheel brake cylinder front left
- r = Brake line to wheel brake cylinder front right
- h = Brake line to wheel brake cylinders of rear axle.
- 2 = Motor relay
- 3 = Valve relay

The hydraulic modulator must not be repaired, but be exchanged only as a complete unit.

Exception: Change of relay

Note on removal:

Unscrew radiator grille and remove fan in left-hand wheel box.

GENERAL INFORMATION FOR REPAIRS AND ON BRAKE SYSTEM

The ABS is basically maintenance-free, however, when working on vehicles with ABS system the following must be noted:

1. When welding with electric welding equipment, pull plug from electronic controller.
2. When painting, the electronic controller may be loaded for a short time to max. + 95°C and for a long time (approx. 2 hours) to max. 85°C.
3. After exchange of hydraulic modulator, controller, wheel-speed sensor and of the wiring harness, as well as after work in which the ABS units are touched (e.g. accident repairs), check the complete ABS system with the tester.
Pay attention to correct assignment of brake lines and wheel-speed-sensor connections at controller as well as wheel-speed-sensor plug connections (see vehicle-specific terminal diagram).
4. Each time after working on the brake system, the latter must be bled and go through low-pressure and high-pressure tests. Check all connections for leaks..
5. Tighten battery terminals to terminal posts of battery.
6. Do not use a fast charger for starting the engine.
7. Never disconnect the battery from the vehicle electrical system when the engine is running.

8. When fast charging, disconnect the battery from the vehicle electrical system.
9. Take care that all connectors of the wiring harness are seated perfectly.
10. Never disconnect or connect the ABS wiring-harness plug from the controller when the ignition is switched on.
11. For reasons of safety, the hydraulic modulator must never be repaired, but be exchanged only as a complete unit.

Excepted from this are the motor relay and the valve relay.

Both relays may be exchanged.

Apart from the brake-line connections, no screws at the hydraulic modulator may be loosened.

Once they are loosened, it is impossible to make the brake circuits leak-free ever again!

There is danger to life !

For production reasons:
continued on the following
coordinate.